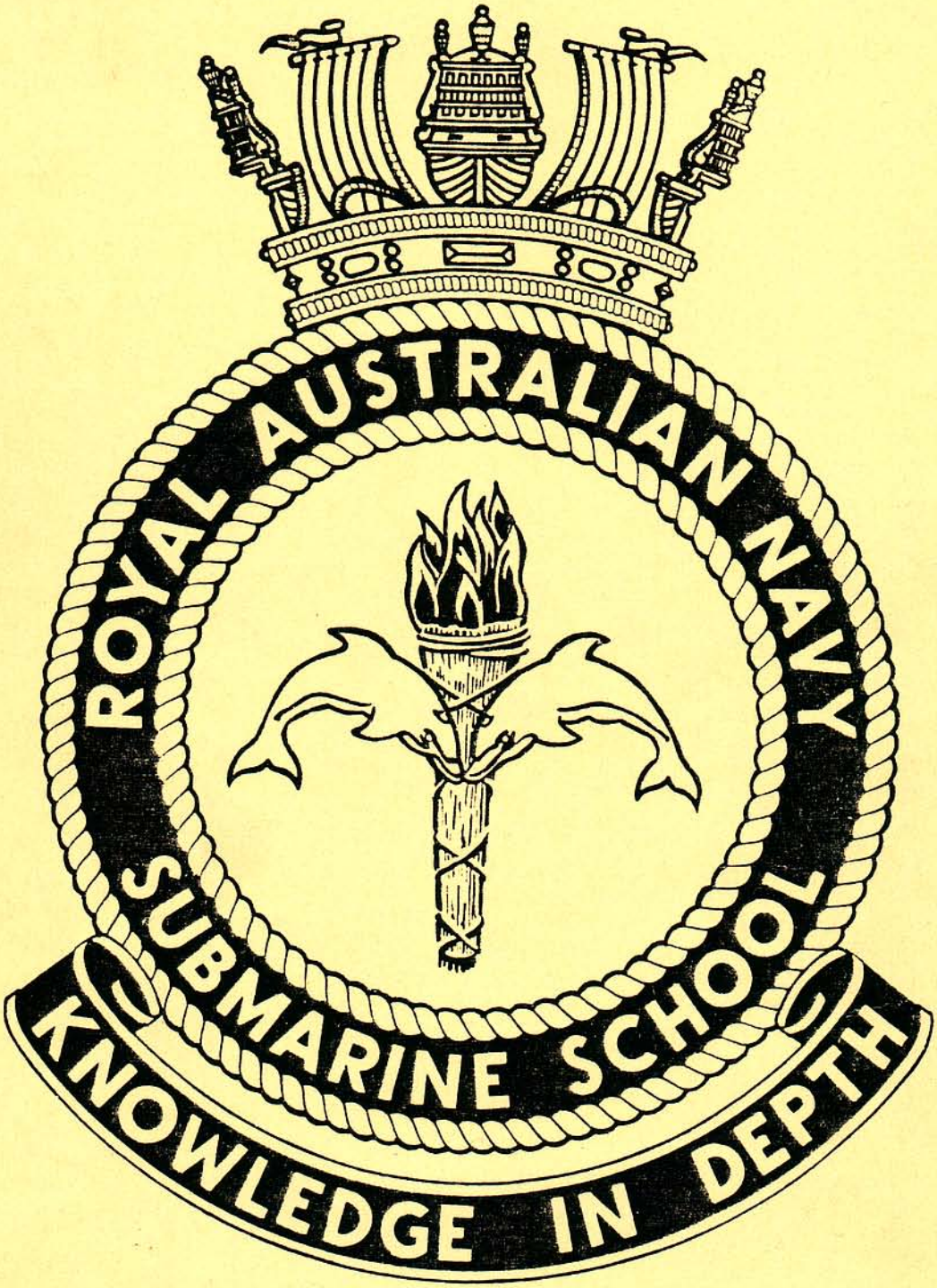

ETS PART 2

MISCELLANEOUS SONARS

ETS PART 2
MISCELLANEOUS SONARS

PAGE	EQUIPMENT
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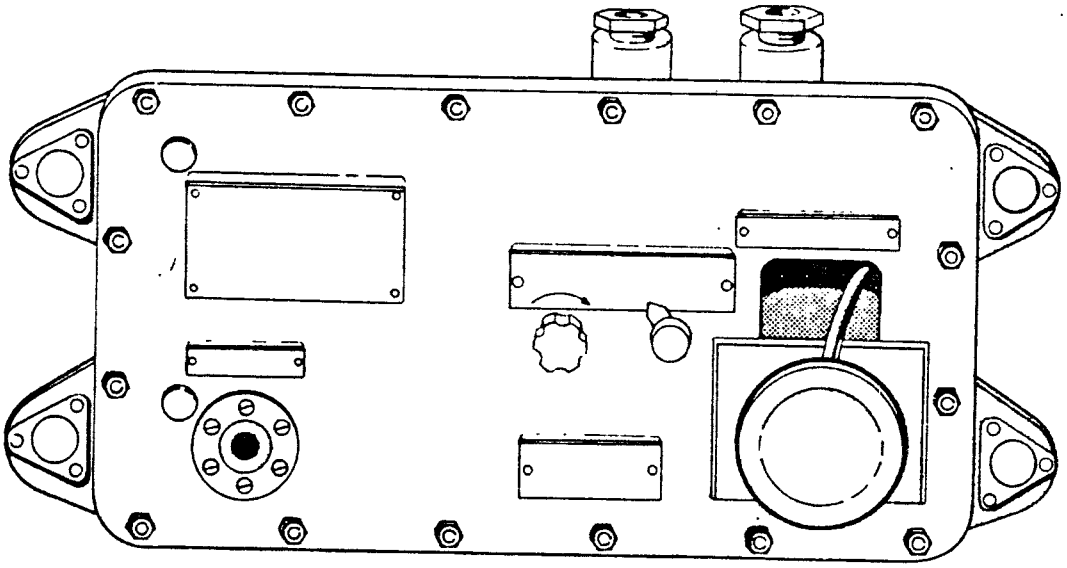
(1)

UNDERWATER

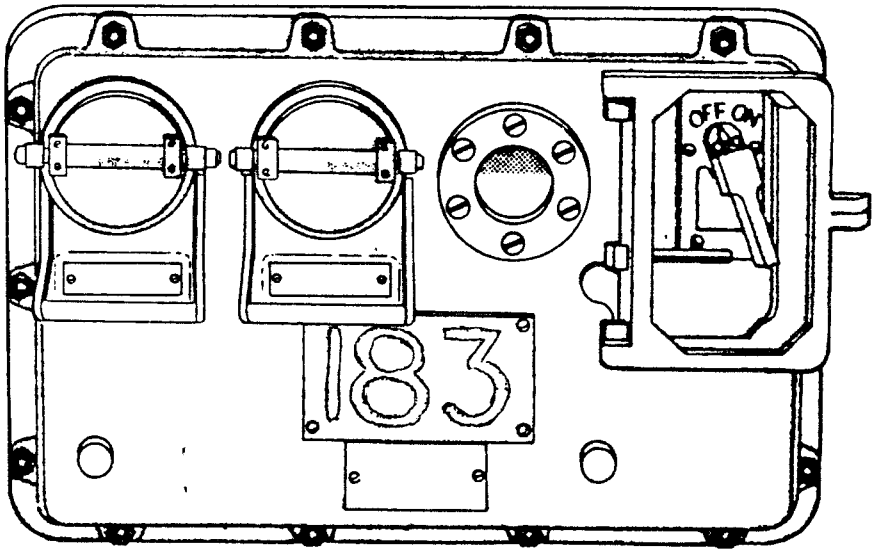
TELEPHONE

TYPE

183



TRANSCEIVER



POWER SUPPLY BOX

183 UNDERWATER TELEPHONE.

QUICK REFERENCE DATA.

POWER REQUIREMENTS	12v BATTERY.
BATTERY LIFE	APPROX. 18 MONTHS. TRANSMIT 22.5 HRS. RECEIVE 12.5 DAYS.
FREQUENCY OF OPERATION	CARRIER 8.0875 KHz. FREQ. RANGE 8.5 to 11 KHz.
MAXIMUM RANGE	APPROX 1,000 YARDS.
TRANSDUCER BEAMWIDTH	120° CONICAL BEAM.
HANDBOOKS	BR 1288 OPERATING & MAINTENANCE A/S 7065/R4 INSTALLATION INSTRUCTIONS. A/S 223 ESTABLISHMENT LIST.

UNDERWATER TELEPHONE TYPE 183

Purpose:
Type 183 is an Emergency Underwater Telephone installed in Submarines to provide a means of communication with rescue ships when a Submarine is in distress.

Brief Description:
A battery operated tranciever with a dual purpose Microphone/Headphone, permanently connected to a fixed transducer in the casing of the Submarine. The set consists of two boxes, the Tranciever and the battery box, which is always kept locked. Also near the set is a battery for use when the set is being tested. The set is able to transmit continuously for 22 ½ hours and recieve for 12 ½ days continuously.

Tranciever:
The tranciever is made up of three sub-units:

(A) Modulator.
(B) Transmitter.
(C) Reciever.

The sub-units are potted in a synthetic resin and enclosed in a metal screening box. Also mounted on the chassis are the O/P transistors, O/P transformer, S/R switch, volume control and the Crystal which is part of the Oscillator.

Circuit Description:
In the same block as the modulator is a crystal controlled oscillator and AGC amplifier for the reciever. The Oscillator supplies the carrier for Modulation and Demodulation. A SSB suppressed carrier system is used.
The S/R swicth controls the operation of the reciever by switching the microphone, transducer and the 12V supply to the reciever of transmitter. The 12V supply to the Modulator Block and the -6V bias supply are not switched by the S/R switch.

Circuit Description: (TX)
With the S/R switch to send, audio signals from the Microphone are connected by the bandpass filter 1L1, 1C1, 1C2 and 1R1. This restricts the input to the transmitter to frequencies between 800 Hz and 3 KHz. The signal is then amplified and then fed by an emitter follower to the Ring Modulator and mixed with the Carrier.
The Carrier of 8.0875 KHz is generated by the Oscillator. The level of the Oscillator is controlled by the diode 2MR1, which regulates the bias of 2VT1 via the Emitter Follower 2VT2.
The output is then connected to a Filter circuit where frequencies higher than 8.8 KHz are passed. Negative feedback ensures low input resistance to this stage. Signal is further amplified in a Driver Stage and fed to a Class B push-pull amplifier output stage. The neon lamp is connected across the Output Transformer and lights when the Output exceeds ½ W.

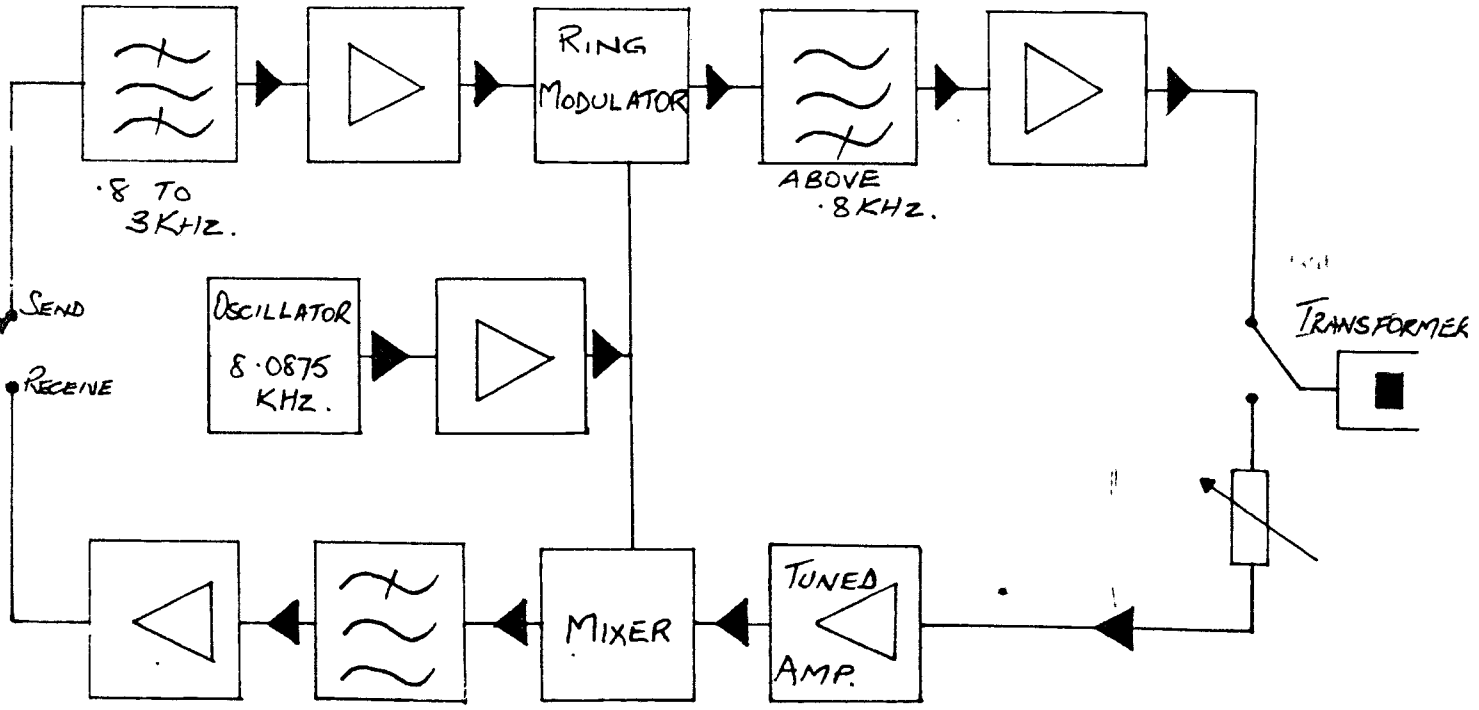
Circuit Description: (RX)
With the S/R switch to recieve, the transducer is connected to the reciever Input Transformer. The gain of the two stages is controlled by the AGC amplifier. The Modulator now functions as a Demodulator, and the signal is mixed with the Carrier. The output of the Demodulator is fed via the Volume Control to a low pass filter. The Output of this filter is now audio and is fed to the reciever Output Transistor, supplying the Microphone which is now used as a Headphone. The reciever Output is 1 mW into a 300 Ohm Microphone/Earpiece. To accomodate this range of signals strengths, the Agc circuits are incorporated to reduce the need for critical setting of the Volume control.

Circuit Description (RX) Cont.
A portion of the amplified signal is tapped of the input to the Modulator and fed to the AGC detector and Amplifier which is in the Modulator Block. To maintain level control between words when recieving speech, the AGC circuit is arranged to Charge quickly and Discharge slowly.

Power Supply:
This is provided by a dry battery. The battery contains a high capacity 12 V section for main HT and a -6V section for bias supply.

Transducer: (120° conical beam over a maximum range of 1000 Yards.)
The Transducer connected to the Sonar 18 3 is the same as the Transducer connected to the Sonar Type 185. Therefore the Capacitance and Insulation requirements are the same.
The Transducer cable comes out of the Tranciever Box and then goes to a Cable Changing Box mounted near by. It is in the Cable Changing Box that the Polythene Cable is connected to the Tranciever Box. The Polythene Cable then goes out of the Submarine through a Hull Gland. The cable then runs along a cable tray until it reaches the Transducer.

Monitor/Test Plugs:
A Monitor plug is connected to the DEAD side of the battery to provide a means for connection of the TEST BATTERIES. The TEST Socket is used to test the FITTED battery under a NO LOAD condition.

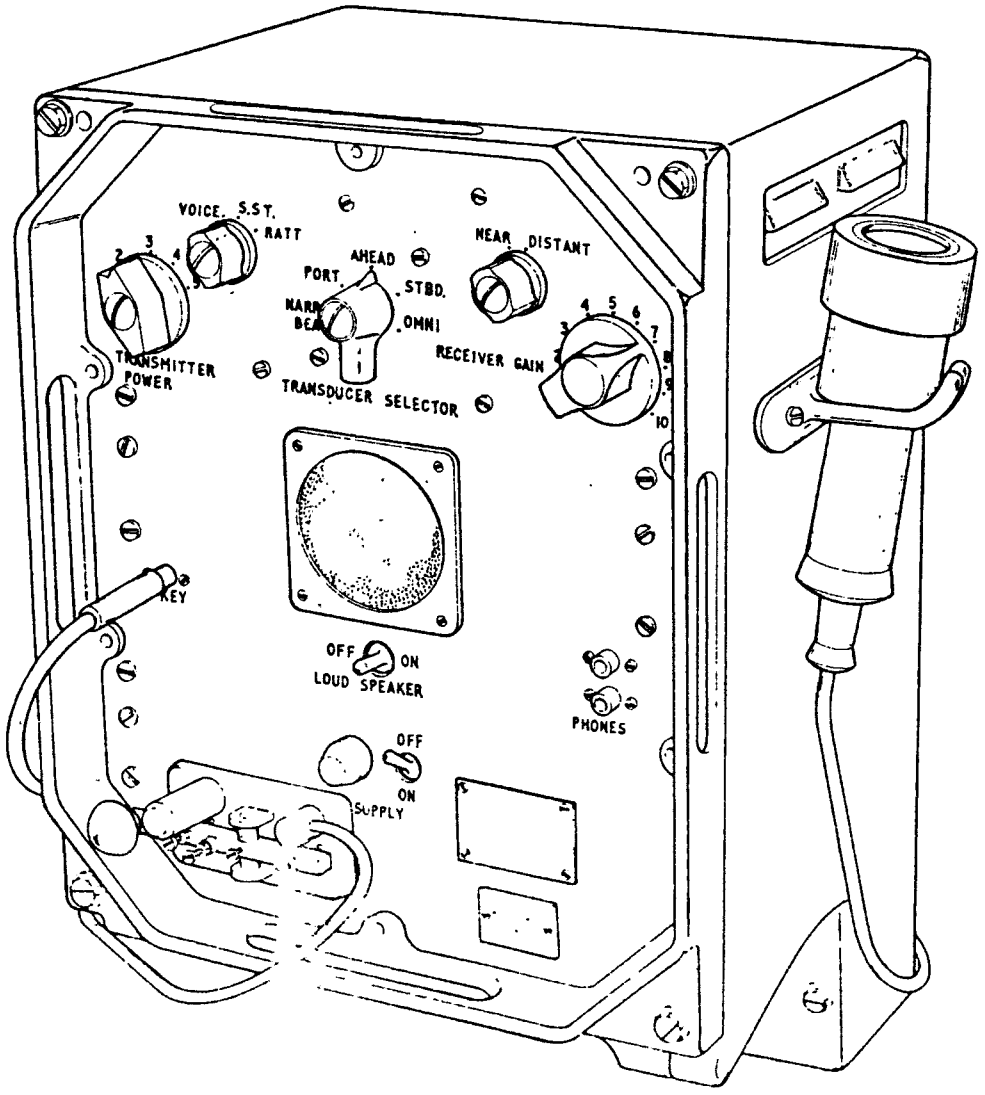


BLOCK DIAGRAM 183 UWT.

UNDERWATER

TELEPHONE

TYPE 185



185 UNDERWATER TELEPHONE.

QUICK REFERENCE DATA.

POWER REQUIREMENTS	115v 60 Hz.
FREQUENCY OF OPERATION	CARRIER 8.0875 KHz.
TRANSDUCER BEAMWIDTH	120° CONICAL BEAM. OMNIDIRECTIONAL.
MODES OF OPERATION	VOICE. SST. RATT.
HANDBOOKS	BR. 219 OPERATION AND MAINTENANCE. A/S 7079 INSTALLATION INSTRUCTIONS. A/S 259 ESTABLISHMENT LIST.

SONAR TYPE 185 UNDERWATER TELEPHONE

Provides either voise or SST communication between surface ships or two submarines.
Communications may be:
(a) Over an arc of 120° upwards or on either beam.
(b) Omnidirectional (A combination of fixed transducers).
These arcs of coverage may be selected by the operation of the Transducer Selector Switch, the positions of which are:
(a) Omni.
(b) Starboard.
(c) Upper. (One to casing, one to Fin.)
(d) Port.

POWER SUPPLIES:

The power unit is supplied with 115 V 50/60 Hz and provides the HT, bias, heater and relay supplies for the equipment.
HT 1 : 650 V for the Transmitter Power Amplifiers.
HT 2 : 200 V for the reciever and transmitter and the screens of the Power Amplifier.

HEATERS:

6.4 V Three similar windings providing heater outputs of 4-5 amps. These three windings when connected in series are used in conjunction with a rectifier to provide approx 19.5 V bias to the Power Amplifier valves V7 and V8.

RELAY:

30 V approximately to operate the S/R relay RLY4

BOOKS OF REFERENCE:

(1) Handbook for U/W TELEPHONE TYPE 185. BR 219.
(2) Establishment list A/S 259.
(3) Instructions for installation A/S 7079

WARNING

When carring out tests on HT1, great care must be taken. Always ensure that C 43 and C 44 are discharged after switching off.

SUMMARY OF OPERATION:

TRANSMISSION

Preamplifier/Oscillator:

With the VOICE/SST switch to VOICE, V1,V2 and V 3 act as amplifiers. With the switch to SST, V1 and V2 act as a 1 KHz oscillator and V 3 remains an amplifier.

Carrier Oscillator and Modulator:

V9 is the carrier frequency oscillator which is crystal controlled.(8.0875 KHz) The output of V9 is fed to the modulator, the outputs of which are fed to the filter FL1, which removes the lower sideband.

Attenuator:
The attenuator consists of a switch potentiometer having four reductions of 10 dB's and is operated by the Transmitter Power Switch on the control panel.

Driver and Power Amplifiers:
V4 is a pentode amplifier whos output feeds V5 and V6, a long tail pair, providing a push-pull output to the power amplifiers V7 and V8. The output of the PA's is fed to the appropriate transducers via the Transducer Selector Switch.

RECEPTION

Preamplifier and Filter:
The recieved signal from the transducer is fed to the transformer, coupled to V10. A pentode amplifier who's output is fed to the bandpass filter FL2. In thr filter unit, there is a 50 dB attenuator which is controlled by the operation of the NEAR/DISTANT switch and is used to attenuate strong signals in the near position. The output of the filter is fed to V11.

Amplification and Demodulation Stages:
V11 and V12 are RC coupled pentode amplifiers. The output of V12 id fed to the demodulator M2, which is also fed from V9 oscillator.

Output Stage:
The output from M2 is fed to a low pass filter circuit and then amplified by V13, the output of which is taken to a loudspeaker and two phones sockets.

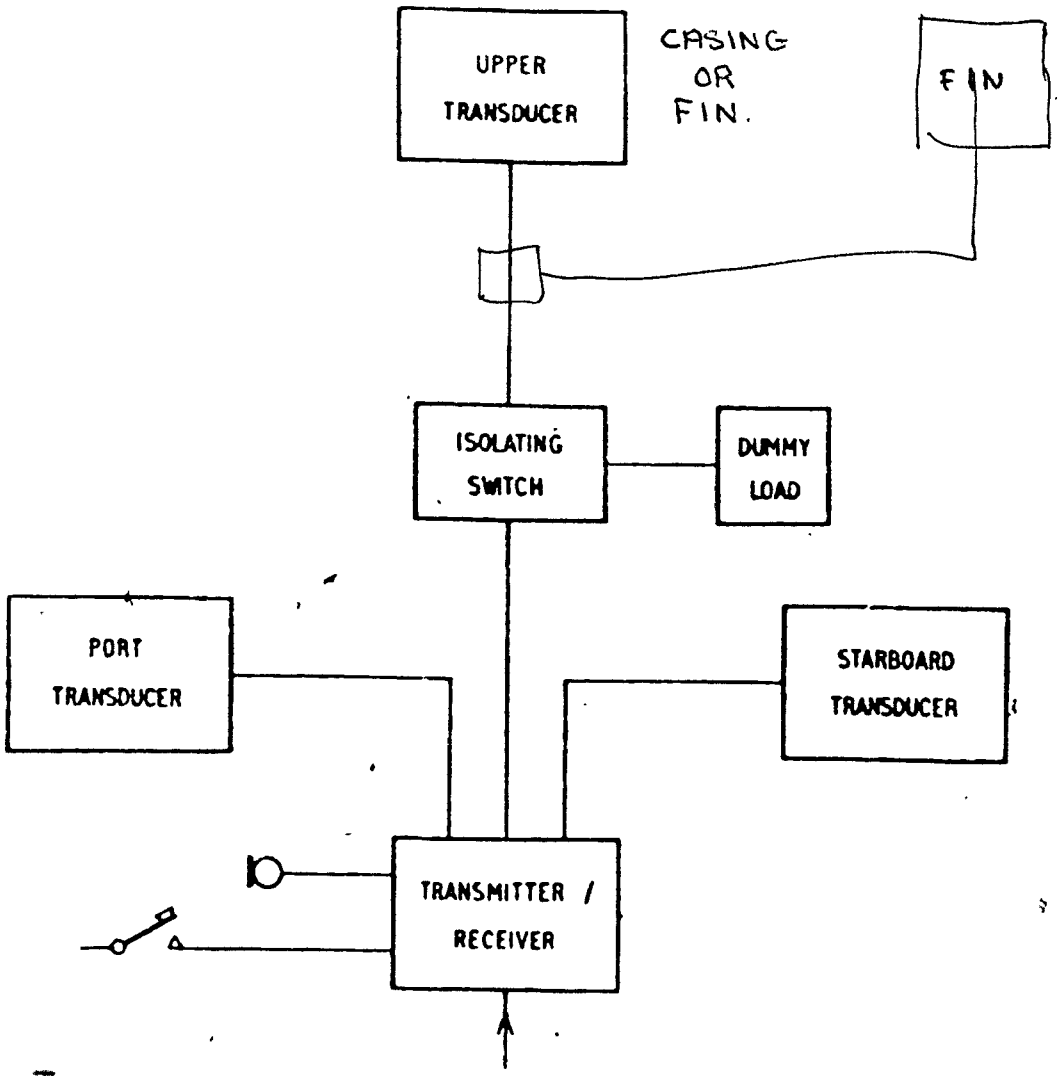
GENERAL

All the electronic components are located in one small cabinet, with the power unit housed in the base and the remaining components on the inside of the front cover. For ease of replacement, a number of components are made up of sub units: These are:
(1) Preamplifier.
(2) Modulator.
(3) Filter.
(4) Driver.
(5) Carrier Oscillator.
(6) Reciever.
(7) Modulator.
(8) Filter.

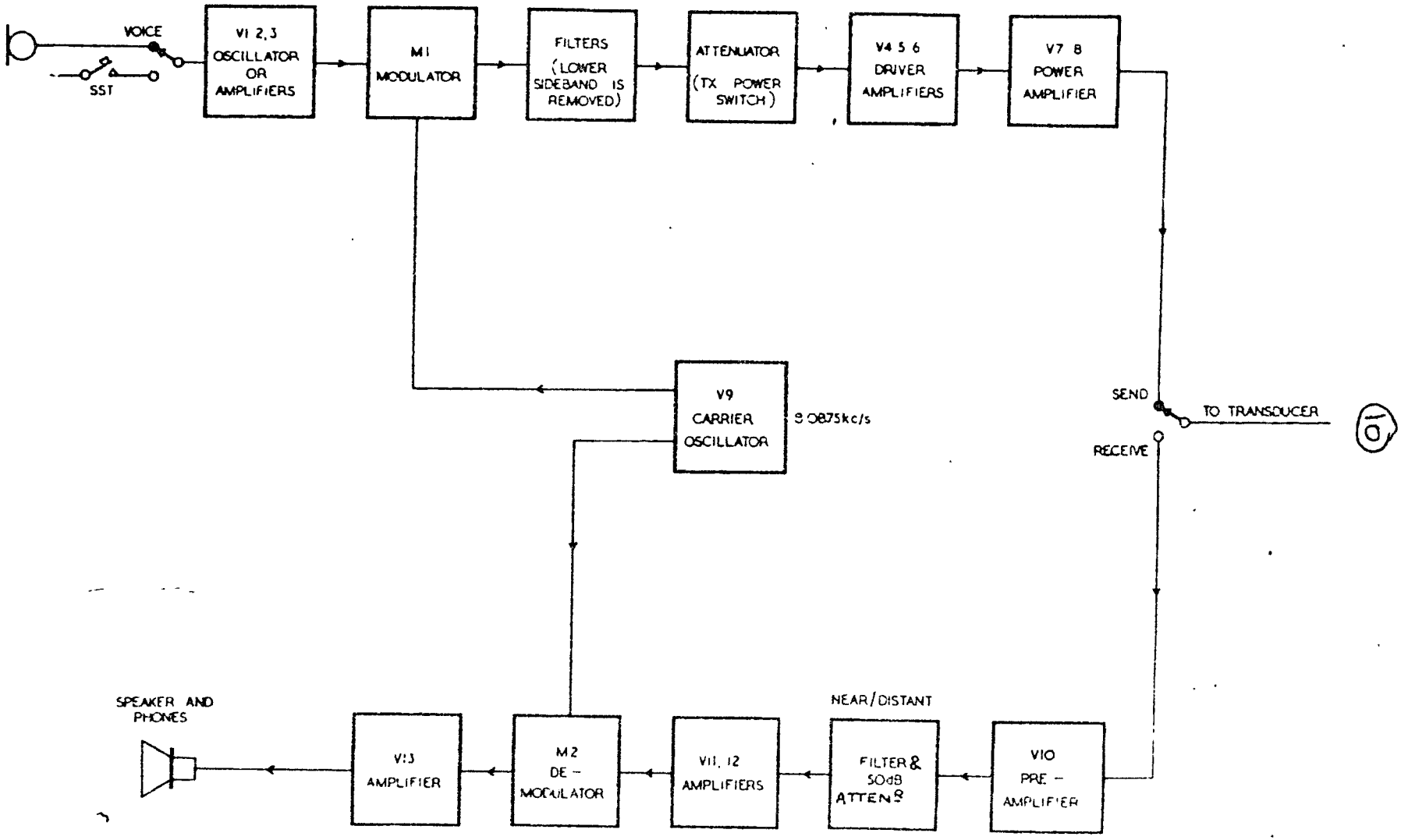
Transmitter Protection Switch:
Is a microswitch operated by the movement of the Transducer Selector Switch, and is open whilst the switch is being changed from one position to another. HT2 is interupted by the switch and is removed from the reciever, the TX preamplifier and thr driver, and the screens of the power amplifier valves. In this way, the transmitter is protected when the load is open circuited while switching from one transducer to another.

Keying Circuit:
With the VOICE/SST switch in the SST position and the Morse Key in the normal position, the output of V3 is short circuited and the oscillations generated by V1 and V2 do not cause any output from the Modulator.
Immediately the key is pressed, the back contact is opened and these oscillations can modulate the carrier and signals are fed to the Power Amplifiers via FL1 and the driver.
The front contact of the Morse key causes RLA/4 to operate.
If this relay were allowed to release immediately the key was released the operator would here background noise in the spaces and confusion would result.
To avoid this, R23 and the combination of C12, C13 and C14 have been added.
There effect is twofold. First, owing to R23 the relay current does not decay to zero, but to some figure slightly less than the release current of the relay and second, the time constant of the delay is set to approximately 2.3 seconds.
With the switch to VOICE, the relay is operated by the microphone ' PRESS TO SPEAK ' switch and is deenergised on release.

Transducer:
The Transducersare made up of Longitudinal sandwich type elements of Barium Titanate, resonant at approximately 10 KHz. Transducer capacitive readings should always be within 300 pF of each other when measured at the console.
Spare Transducers are normally supplied with a lenght of cable. In the case of Polythene cables, it is not intended that the whole of the cable run be replaced. A joint should be made as close as possible to the old transducer. It is essential that the lenght of the cable run be maintianed in order that the capacitance figures are within the prescribed limits. Capacitance between the connections from each transducer, taken at the console connection box, should be at least 6000 pF and the insulation between them at least 2.5 Megohms.



TYPE 185 — TX/RX BLOCK DIAGRAM



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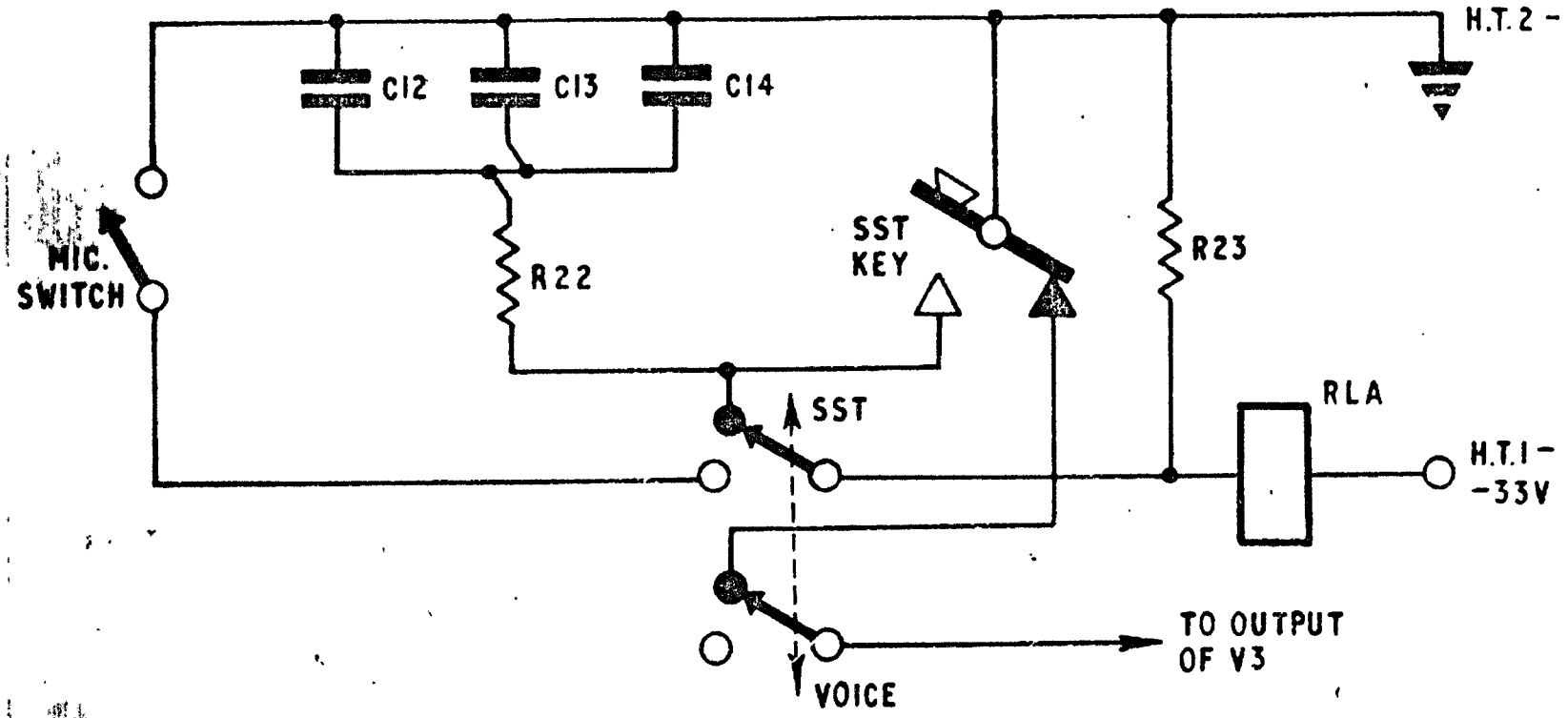
TYPE 185-KEYING CIRCUIT



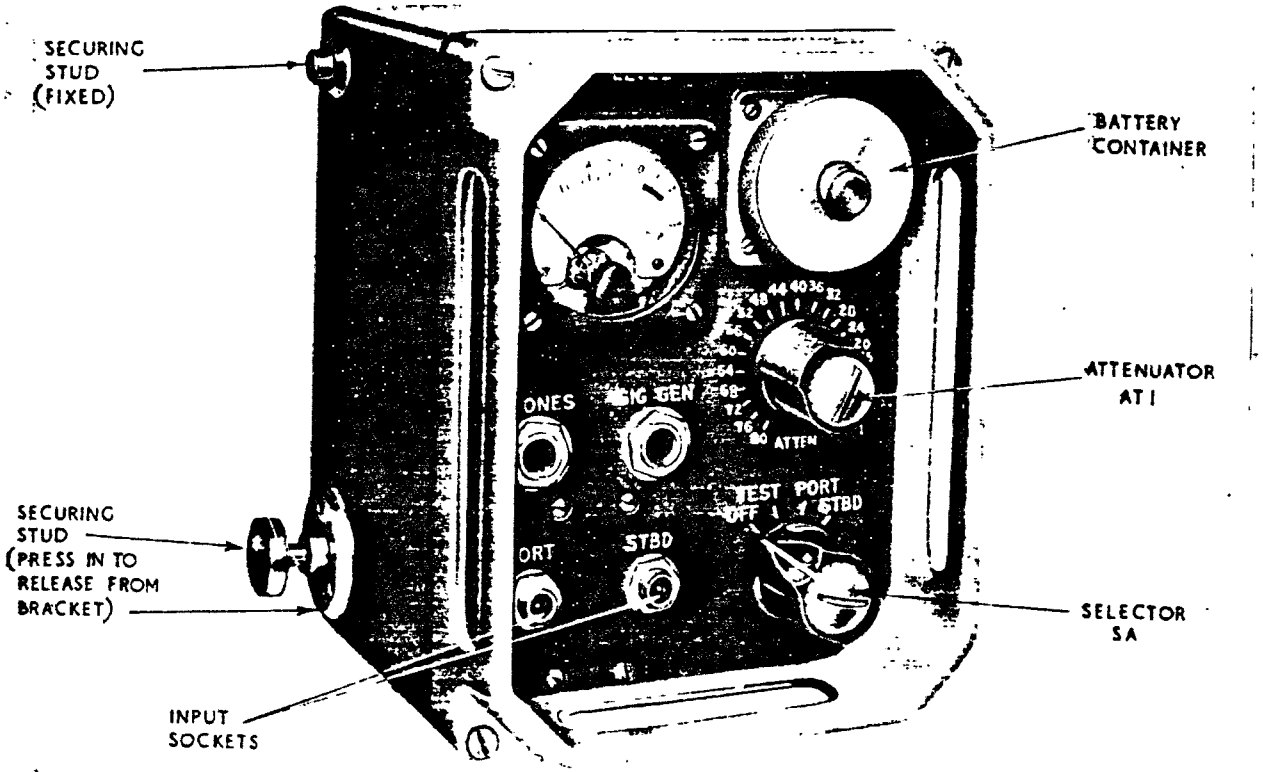
FUNCTIONS OF RLA

DE-ENERGISED	CONTACT	ENERGISED
TXDR TO RX	1	TXDR TO TX
H.T. TO RX	2	H.T. TO P.A. SCREENS, TX PRE-AMP DRIVERS
SPARE	3	SPARE

CAVITATION

INDICATOR

TYPE 189



189 CAVITATION METER.

QUICK REFERENCE DATA.

POWER REQUIREMENTS.....6.5v MALLORY TYPE BATTERY.

BATTERY LIFE.....APPROX. 200 HOURS.

FREQUENCY OF OPERATION.....400Hz to 3KHz.

SENSITIVITY.....±3db.

HANDBOOKS.....BR. 2225 OPERATION AND MAINTENANCE.
A/S 7079 INSTALLATION INSTRUCTIONS.
A/S 269 ESTABLISHMENT LIST.

A/S TYPE 189.

PURPOSE:

Type 189 is installed in a submarine as a cavitation indicator. The portable version is carried on submarines as a machinery monitor.

FUNCTION:

To provide aural detection of the onset of propellor cavitation in submarines. A portable version may be used to monitor both aurally and by meter, machinery vibration and noise producing sources in submarines and surface vessels. The portable version can also be used to detect worn bearings and noisy gears.

CAPABILITIES AND LIMITATIONS:

Type 189 allows the onset of cavitation to be determined to within 5rpm, and allows comparative measurement of propellor noise over the range of levels normally encountered. Correctly used, it can give comparative measurements, reproducing over a period to within about ±3db of the vibration levels of machinery such as gear boxes.

CAVITATION INDICATOR:

Two accelerometers mounted to the internal frames of the pressure hull, or a hydrophone mounted externally to the pressure hull, feed propellor noise to an amplifier in the control room. The noise is audible by headset and its level is given on a meter.

MAJOR UNITS:

1. Amplifier.
2. Accelerometers.
3. Hydrophones. (in lieu of accelerometers.)
4. Junction boxes. (two in number.)

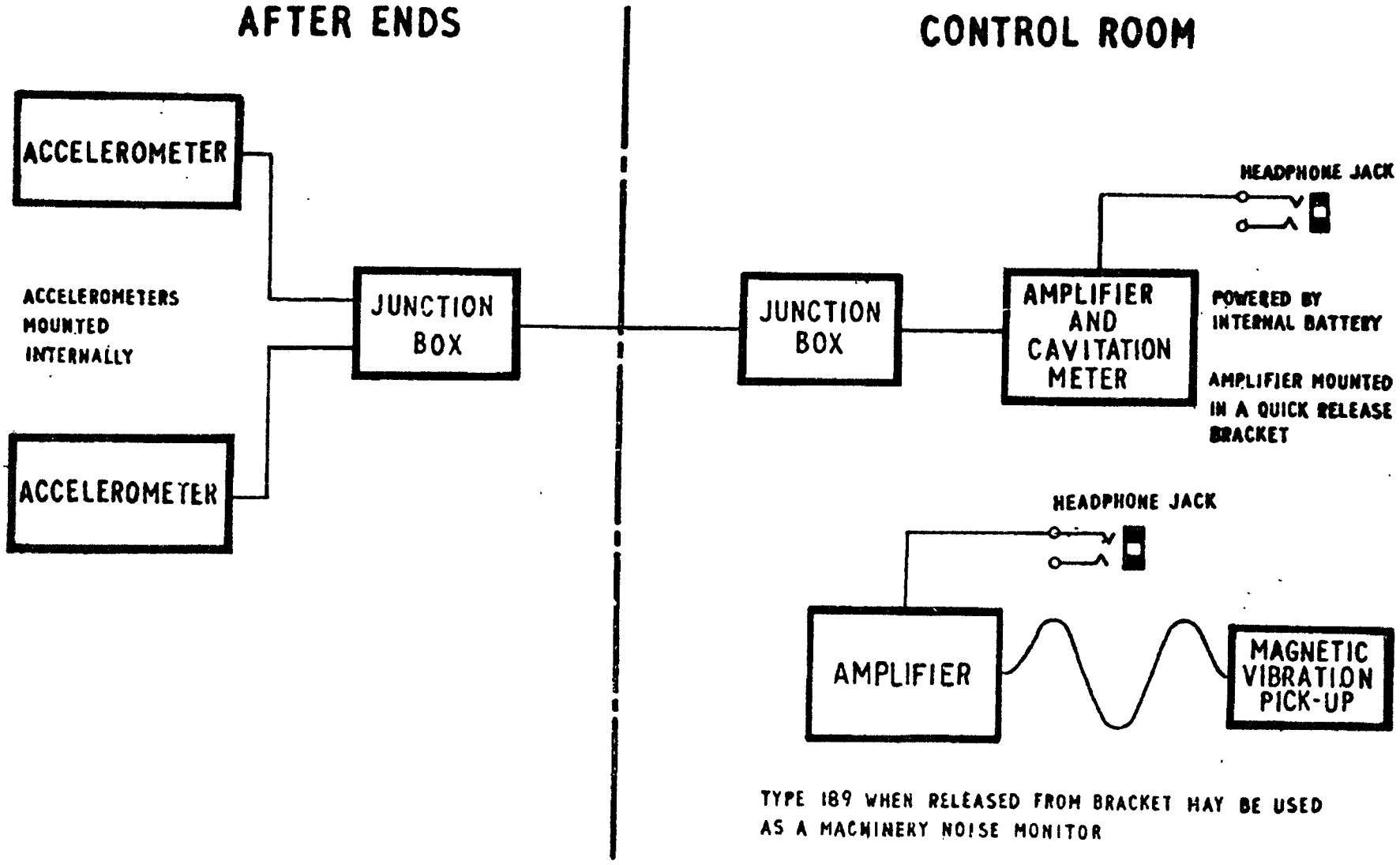
PORTABLE MACHINERY NOISE MONITOR:

A portable vibration pickup is attached to the machine to be monitored. The signal is monitored by headset and meter by means of an amplifier. (As for cavitation indicator.)

MAJOR UNITS:

1. Amplifier.
2. Vibrator.
3. Portable stowage brackets.

CAVITATION INDICATOR TYPE 189



(12)

POWER REQUIREMENTS:

Powered from an internally stowed 6.5V mercury battery. Normal life of the battery is 200 hours.

FREQUENCY OF OPERATION:

400Hz to 3KHz with a reduced response below 400Hz.

TECHNICAL DESCRIPTION:

CAVITATION MONITOR:

Comprises two accelerometers(or hydrophones) and an amplifier. Propellor noises are picked up by the accelerators and may be heard in the headphones when plugged into the amplifier. A meter on the amplifier gives an indication of the overall noise level. Since the first onset of cavitation is more readily detected as a change in the character of the noise rather than increase in level, the headphones are used to find the critical speed of the propellors at which cavitation commences. The meter is used only to assist in maintaining quiet running once the critical propellor speed has been found.

ACCELEROMETERS:

The accelerometers are small piezo-electric devices which are bolted to the frames of the pressure hull and respond to sympathetic vibrations caused by the propellors. The accelerometers are so called because, within the frequency range for which they are designed, the O/P signal has RMS amplitude proportional to the mean acceleration of the vibrating surface to which they are attached, and is of the same frequency as the vibration. Since the base plate of each accelerometer is bolted to the pressure hull, which has a large mass and large area, the O/P signal will depend mainly on vibration of the pressure hull. Airborn sound will have little effect unless it can cause the hull to vibrate in sympathy.

AMPLIFIER:

Uses seven transistors and is powered by a 6.5V(nominal) Mallory type battery. The battery is contained within the amplifier and may be withdrawn by unscrewing a cap on the front panel. A built in test facility allows the meter of the amplifier to be used to check the battery voltage.

CABLING:

The accelerometers are each fitted with fifteen feet of coaxial cable. These cables are run in clips to a junction box. From the junction box, the connections are carried by twin cored screened cables, the screen being common to both circuits. This cable terminates in a second junction box in the control room, from which coaxial cables connect to the I/P sockets of the amplifier.

FREQUENCY RESPONSE:

The important components of machinery and cavitation noise lie betwwen a few Hz and 3KHz, with the lower frequency components tending to be of greater amplitude than the higher frequency ones. Thus the system requires a response which is approximately equal for all the frequencies from 400Hz to 3KHz, but decreased for frequencies below 400Hz. The accelerometers have a frequency response which is level within ±2db from zero to 3KHz, but have a resonant frequency at about 5KHz, giving a 40db increase in sensitivity at that frequency. The amplifier is therefore equipped with a low pas filter which rejects all frequencies above 3KHz.

FREQUENCY RESPONSE:

..... The accelerometers have a source impedance which is equivalent to a series capacitance of 4000pF when the circuit is loaded by the I/P impedance of the amplifier. Losses across this capacitance cause a decrease in response to frequencies below 400Hz due to coupling losses and much reduced above 3KHz by the low pass filter.

PORTABLE MACHINERY NOISE MONITORS:

Requires no permanent cable runs and comprises a vibration pick up, an amplifier and a headset, all of which are readily portable. In use, the vibration pick up is attached by means of its magnet to the machineto be monitored. Readings of vibrations are taken on the meter of the amplifier, and the characteristics of the vibration are checked aurally by use of the headset. Provided the vibration pick up is attached in exactly the same spot and the speed of the machine remains constant, meter readings are reproducable to within ±3db or less. The portable machinery noise monitor uses the same type of amplifier as the cavitation indicator.
The vibration pick up is similar to the accelerometers of the cavitation indicator, but is equipped with a cylindrical magnet instead of a mounting stud. Frequency response and other characteristics of the two equipments are therefore similar.

VARIANTS:

Two types of amplifier are available. AP191451 for bulkhead mounting or portable use, and AP192229 for panel mounting. The two types are electrically similar, except that the panel mounting type has provision for only one I/P(from a hydrophone), whereas the bulkhead type provides for two I/P's(PORT and STARBOARD) from two accelerometers.

MAINTENANCE:

Service is limited to the checking and replacement of the batteries. The two amplifiers supplied are normally interchangeable, so allowing the amplifier of the portable machinery noise indicator to be used as as a ready use spare for the cavitation indicator. As transistors are used in this set, care must be taken when using test instruments that the transistors are not burnt out.

NOTE:

The readings obtained from the type 189 are to some extent unique to the vessel. A cross reference to absolute levels may be obtained during routine noise ranging.

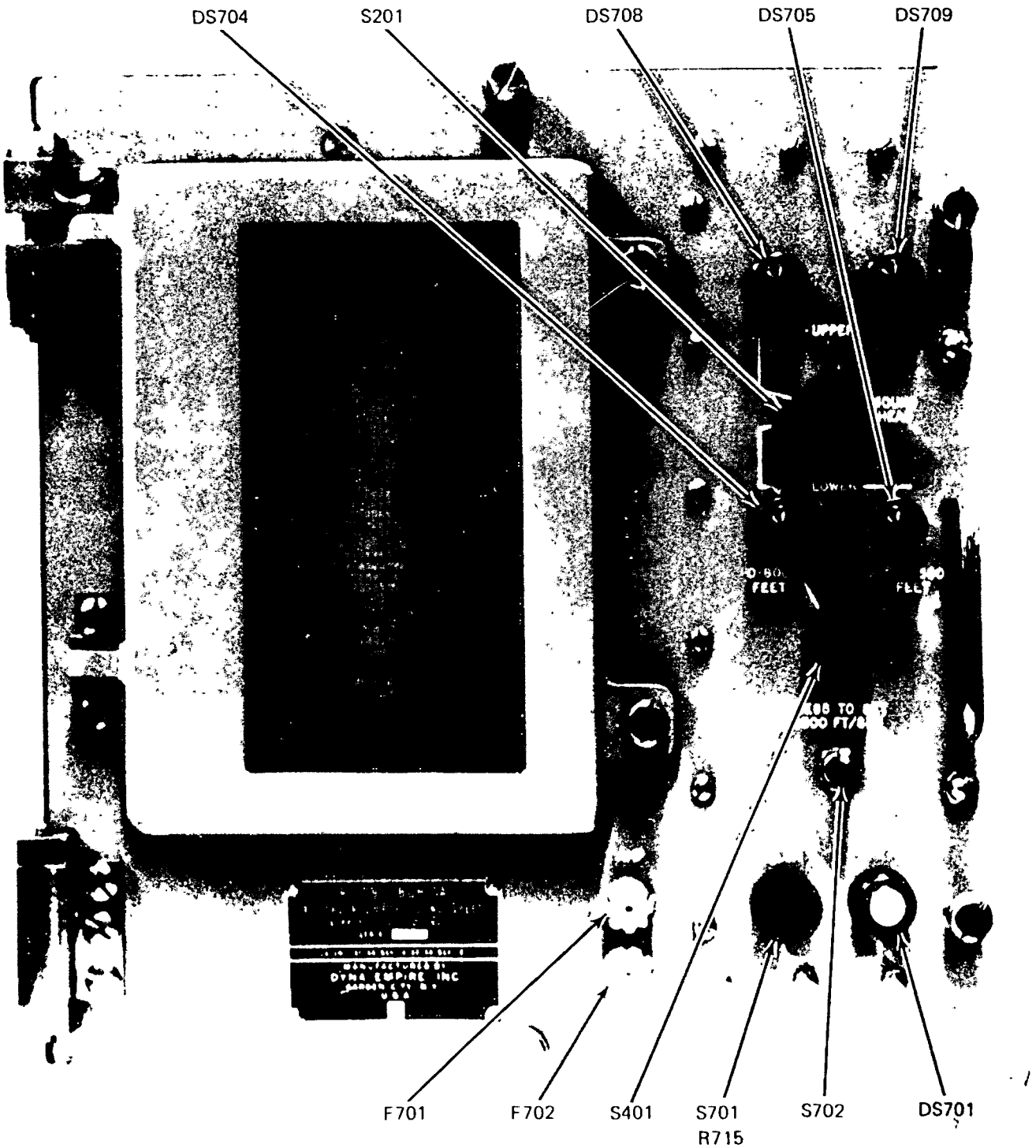
REFERENCES:

1. BR 2225 Handbook.
2. A/S 269 "E" Lists-
3. A/S 7079 Installation Specifications.

VELOCITY METER

TYPE 2004

(AN/BQH-1B)



QUICK REFERENCE DATA FOR 2004

POWER REQUIREMENTS:

Operable over a range of 103 V to 138 V 400 Hz Single Phase. (Nominal 115V) Input power requirements are 55 W single Phase power.

TEMPERATURE RANGE:

The Transducer operates continually in Sea Water at any Temperature between -2.2°C to 35.5°C. The Recorder unit operates continually over a Temperature Range 0°C to 50°C.

OUTPUT DISPLAY:

Recorder Sound Velocity information is displayed as rotation of a drum. Depth information is displayed by position of a stylus which writes on the Velocity Drum.

DEPTH CALIBRATION:

0 to 1500 Feet in two overlapping ranges.
0 to 800 Feet and 700 to 1500 Feet.

SOUND VELOCITY RANGE:
4600 to 5100 Feet per second in 5 Feet per second increments.

HANDBOOK

NAVSEA 0967-LP-932-0010

SONAR TYPE 2004 (AN/BQH-1B)

This is an American sonar and is called Depth-Sound speed measuring set. It's function is to plot a graph of the Speed of Sound in water against Depth. This information is used to :

(A) Give accurate ranging on active Sonars.
(B) Plot the paths of sound rays, either by Hand or on the SFCS.

It is a completely Transistorized equipment and consists of:

(A) Two Sound Heads (Transducer Assemblies), one fitted in the top of the FIN, the other in the FOR'D end of the KEEL.
(B) One Depth Element, fitted in the control room vicinity.
(C) One Recorder fitted in the Control Room.

GENERAL DESCRIPTION:

The speed and path of Sound waves in Sea water are affected by SALINITY, TEMPERATURE and PRESSURE. Previous instuments measured these individual factors and computed the answer. Type 2004 transmits a pulse over a fixed distance and measures the time taken, thus producing the Speed of Sound directly.
A Chart is normally only produced when the Submarine is Descending or Ascending, and the leading sound Head should always be selected i.e. The UPPER Sound Head when ascending and the LOWER Sound Head when descending.
The Sound Heads and Depth Element are sealed units and should not be opened by ship's staff without special permission.

SOUND HEAD:

A Free running Crystal Oscillator produces a 64.8 KHz output to a Clipper/Differentiator. The clipper converts the Sine Wave to a Square wave, which is then Differentiated to produce Positive and Negative going 'spikes'. The Positive spikes are blocked by diodes. The Negative spikes are fed to a Frequency Divider, or circuit which produces one output pulse for every Two input Pulses. This is done to produce trigger wave forms with very rapid rise times.

The 32.4 KHz output (this is a PRF) is applied to the output amplifier and Acoustic Transmitter. The pulse length is approximately 1u Second, with a peak amplitude of 6V (approximately) with respect to ground. The Transmitter converts the signal into a sound wave with a carrier frequency of about 3 MHz.
Each pulse is also passed to a bistable multivibrator which assumes a conducting or 'ON' state. The Acoustic pulse is reflected twice and picked up by the Acoustic Reciever which converts it into an electrical signal. This low level signal is passed to a high gain, untuned Amplifier (Q101), Emitter Follower (Q102) and a thresholding circuit (Q103). The latter is normally biased beyond cutoff and prevents random signals (WATER NOISES) from operating succesive circuits.

The output of the threshold circuit is passed to a trigger generator (Q104 and Q105). These two form a SCHMITT Trigger (a Monostable Multivibrator). This produces an output waveform with a rise time of less than 1uS. The output is Differentiated, and the Negative going Pulse causes the Bistable to cease conducting, or assume the 'OFF' state. This completes one cycle of the Transmit and Recieve sequence, the length of time taken being decided by the water around the Sound Head, and measured by the length of time the Bistable Multivibrator was switched 'ON'.

The Characteristics of the (varying) Square Wave output of the bistable are thus related to Speed of Sound. This waveform is passed to a clamping circuit and is then Integrated (by C230 and R230 and cable Capacitance) to give a DC voltage, the level of which varies as a function of the Speed of Sound in water. The Integration circuit is in the Recorder.

A Calibration switch is provided at the recorder, and is marked 'PRESS TO SET 4800 Ft/Sec'. It causes a fixed output from the frequency divider to be passed directly to the Bistable Multivibrator. The Recorder should then run to a figure close to 4800 Ft/Sec. (The exact figure is obtained from the TEST DATA SHEETS for the particular Sound Head).

Sound Heads should be handled with great care to avoid damaging or offsetting the Transducers. The cables (four in number) enter the Sound Head and the Pressure Hull by Polythene Moulded Glands. Replacement of a Sound Head therefore necessitates cutting and joining of these four cables. Cable length should be maintained (125 Feet).

Both Sound Heads are mounted in ducted cavities which ensure a free flow of water with a minimum of cavitation and turbulence.

DEPTH:
The Depth Element is a variable Reluctance device. It is excited by a 7.5 V 400 Hz supply from the Recorder. Sea water pressure is supplied by a Depth Gauge connection and any alteration is detected by a Diaphragm, which unbalances the Magnetic circuit. This produces an error signal which feeds the Stylus Servo (in the Recorder), which runs to nullify the error and causes the Stylus to indicate the correct depth.

RECORDER:
The recorder is a two channel Servo mechanism. It recieves signals from the Sound Head and Depth element to drive the DRUM and STYLUS respectively. The Drum carries a renewable peripheral chart which is capable of displaying Sound Speeds between 4600 and 5100 Ft/Sec in steps of 5 Ft/Sec.

Depth is displayed in one of two ranges, 0 to 800 Feet and 700 to 1500 Feet, selected by a two position switch. A second two position switch selects the required Sound Head. The positions of the two switches are permutated to illuminate any one of four indicator lamps.

REFERENCES:

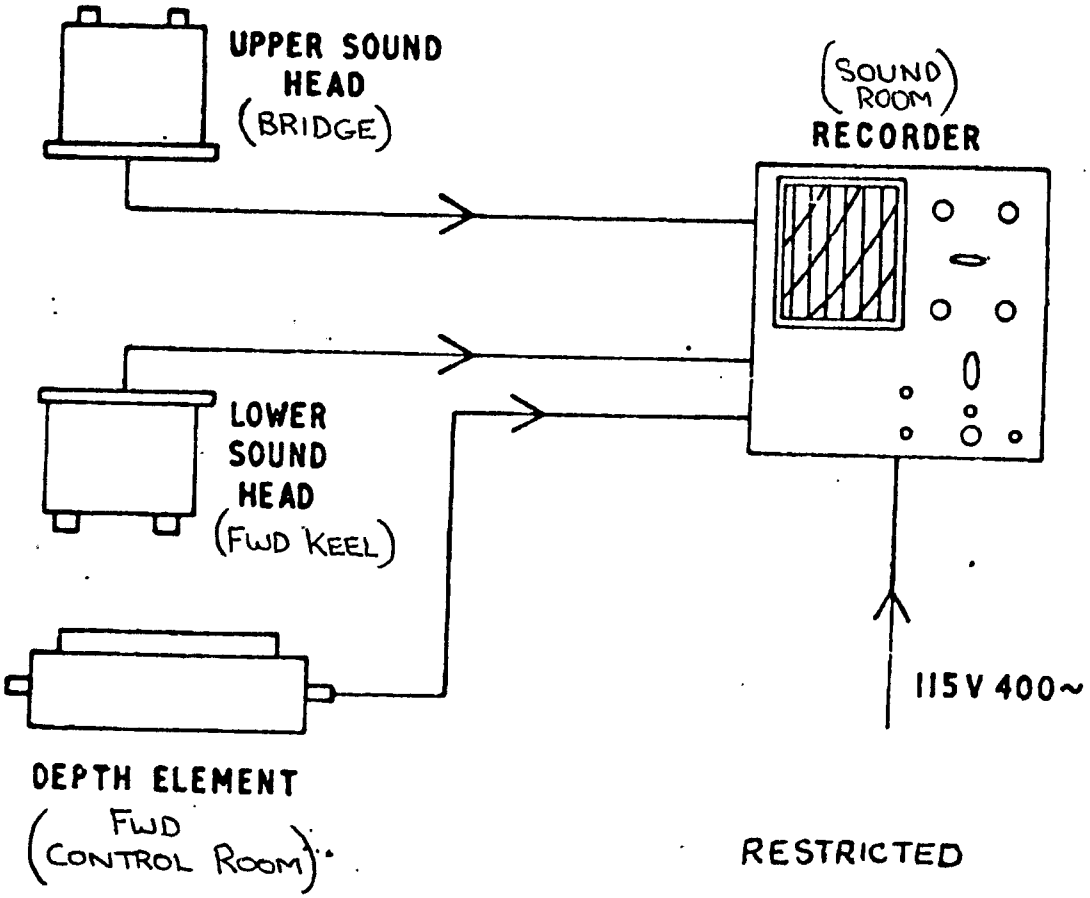
(A) Handbook - NAVSHIPS 0967-932-0010.
(B) Installation Specification - A/S 7918.
(C) Sound Head test data sheets.

CALIBRATION:
The full Calibration procedure is contained in NAVSHIPS 0967-932-0010, pages 2-10 to 2-12, paragraph 2-8a and 2-8b.
The two servos are AC. The DC level represents the sound of speed is therefore used to control the operation of a modulator, which produces a 400 Hz signal, the level of which follows the DC level. This varying 400 Hz controls the Drum Servo.

TYPE 2004 MODULATOR OPERATION:
The primary of Transformer T205 is supplied with a reference supply of 400 Hz. This is used to 'switch' the diodes in the Bridge Circuit.
The DC potential derived from the Sound Head signal is applied to the centre tap of T205 secondary, and a DC potential from a resetting potentiometer is applied to the centre tap of T206 primary.
Consider an instant when the reference supply causes point A to be positive with respect to point B. This will cause the appropriate pair of diodes to conduct. If a difference of potential exists between the two centre taps, a current (DC) will flow through both diodes (Ip1) and P1 half of T206 primary.
For the next half cycle of the reference supply, point B is positive with respect to point A. The other pair of diodes will now conduct, giving current (IP2) through P2 half of T206 primary. The 2 currents IP1 and IP2 are following in opposite directions in T206 primary causing an alternating voltage at 400 Hz in the secondary. The amplitude of this induced secondary voltageis proportional to the potential difference between the two centre taps, and it is used to drive the Drum servo and resetting potentiometer.

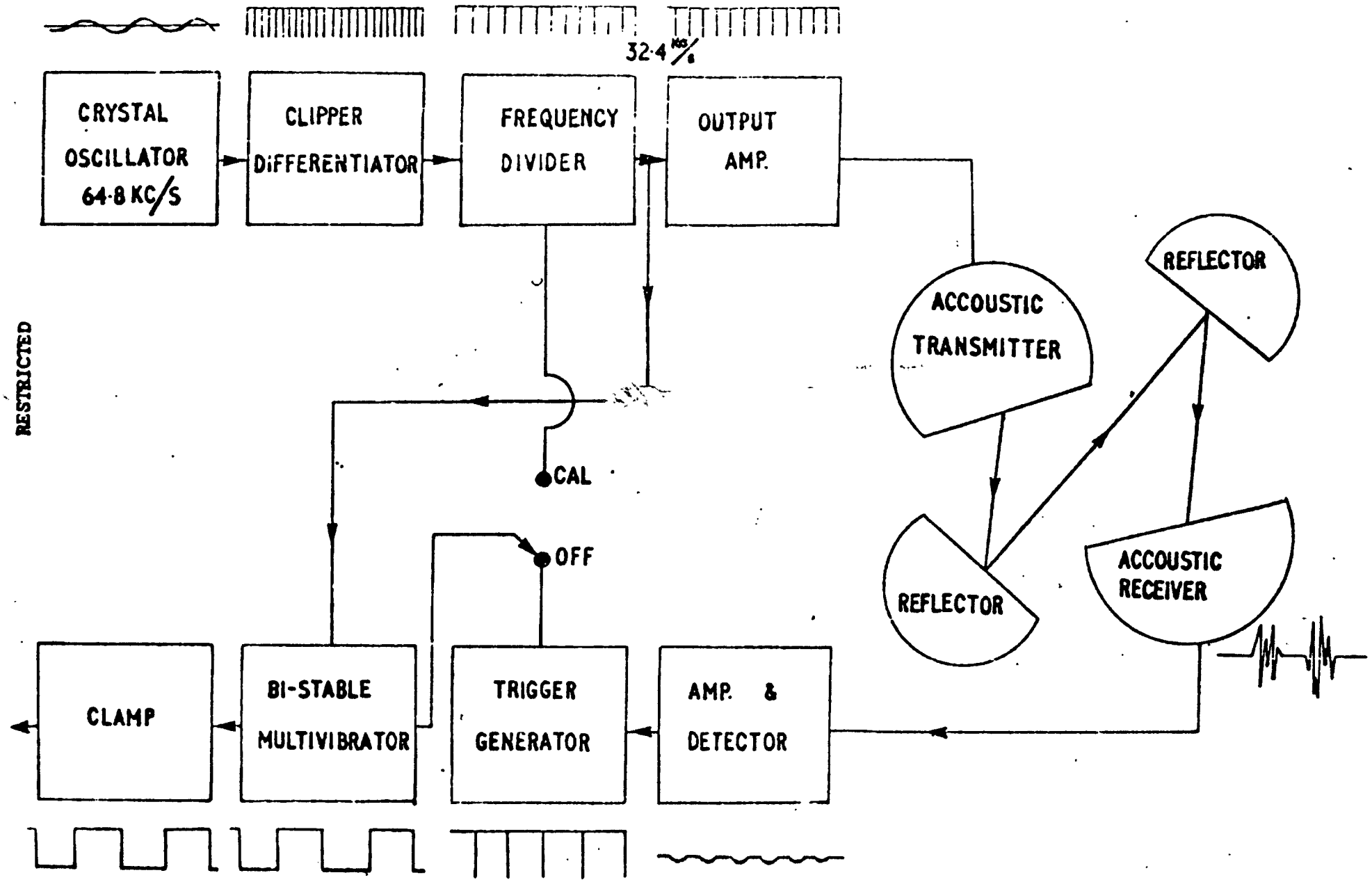
SONAR TYPE 2004

OVERALL BLOCK DIAGRAM



RESTRICTED

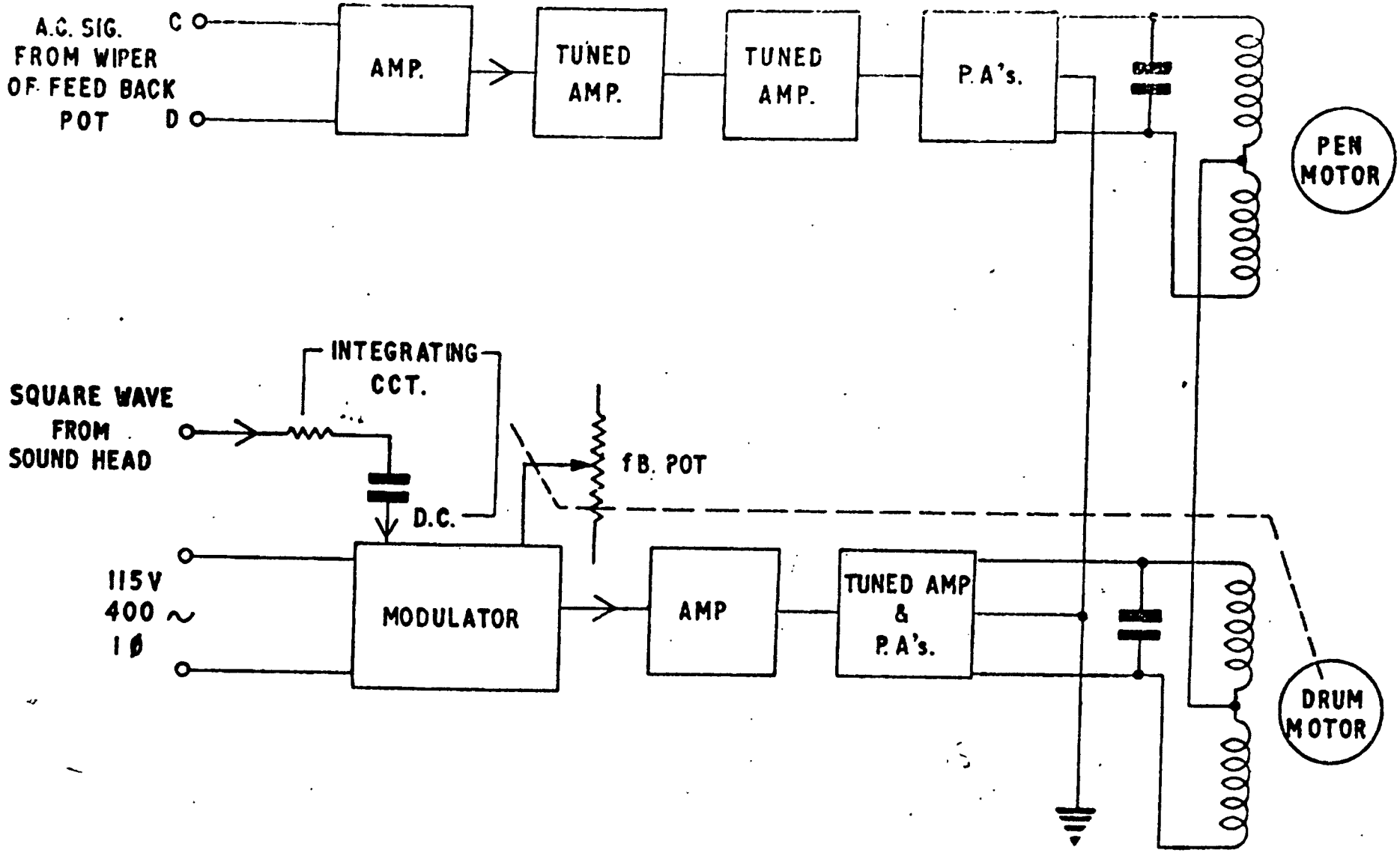
SOUND HEAD FUNCTIONAL BLOCK (SONAR TYPE 2004)



RESTRICTED

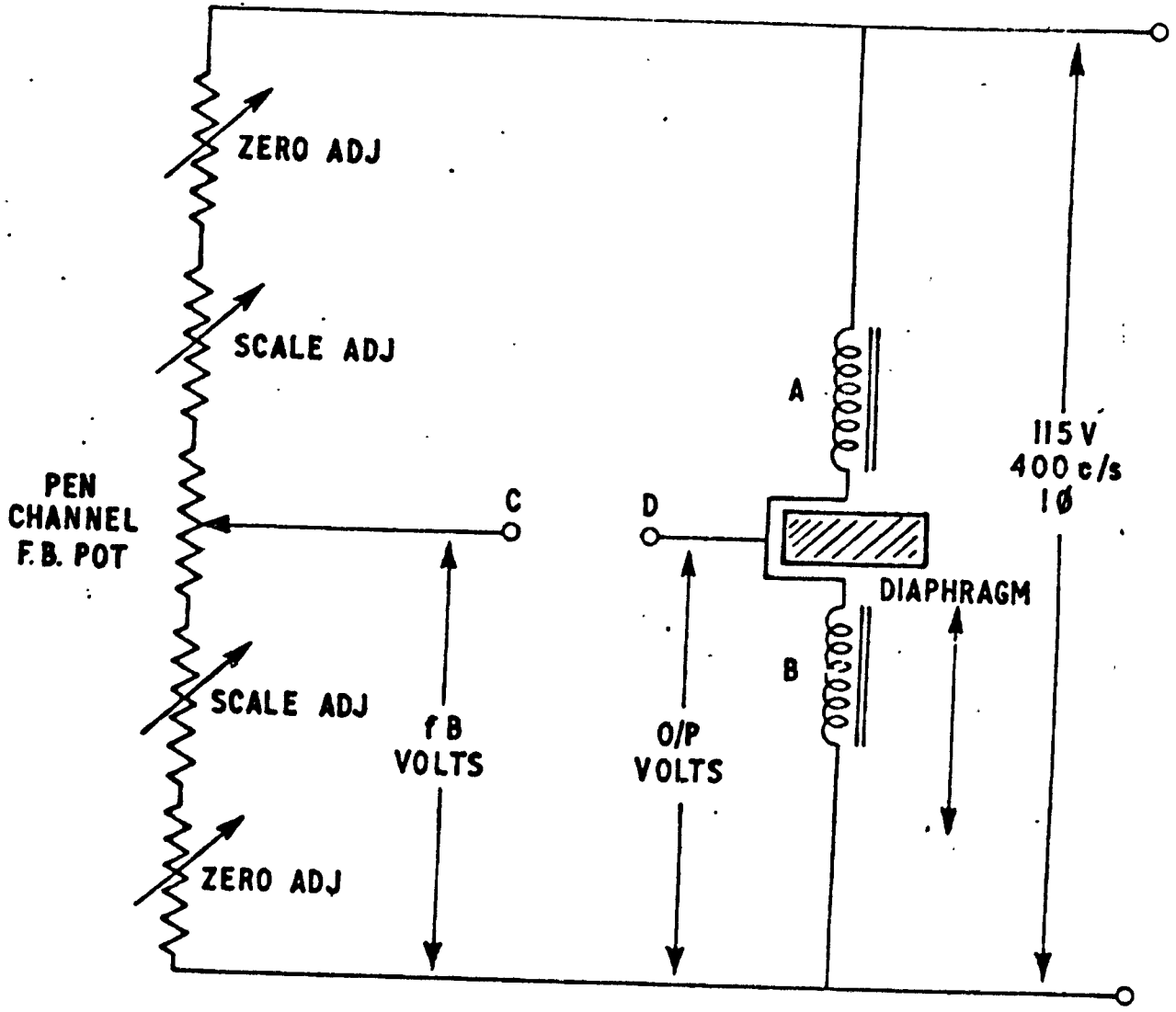
SONAR TYPE 2004

RECORDER BLOCK DIAGRAM

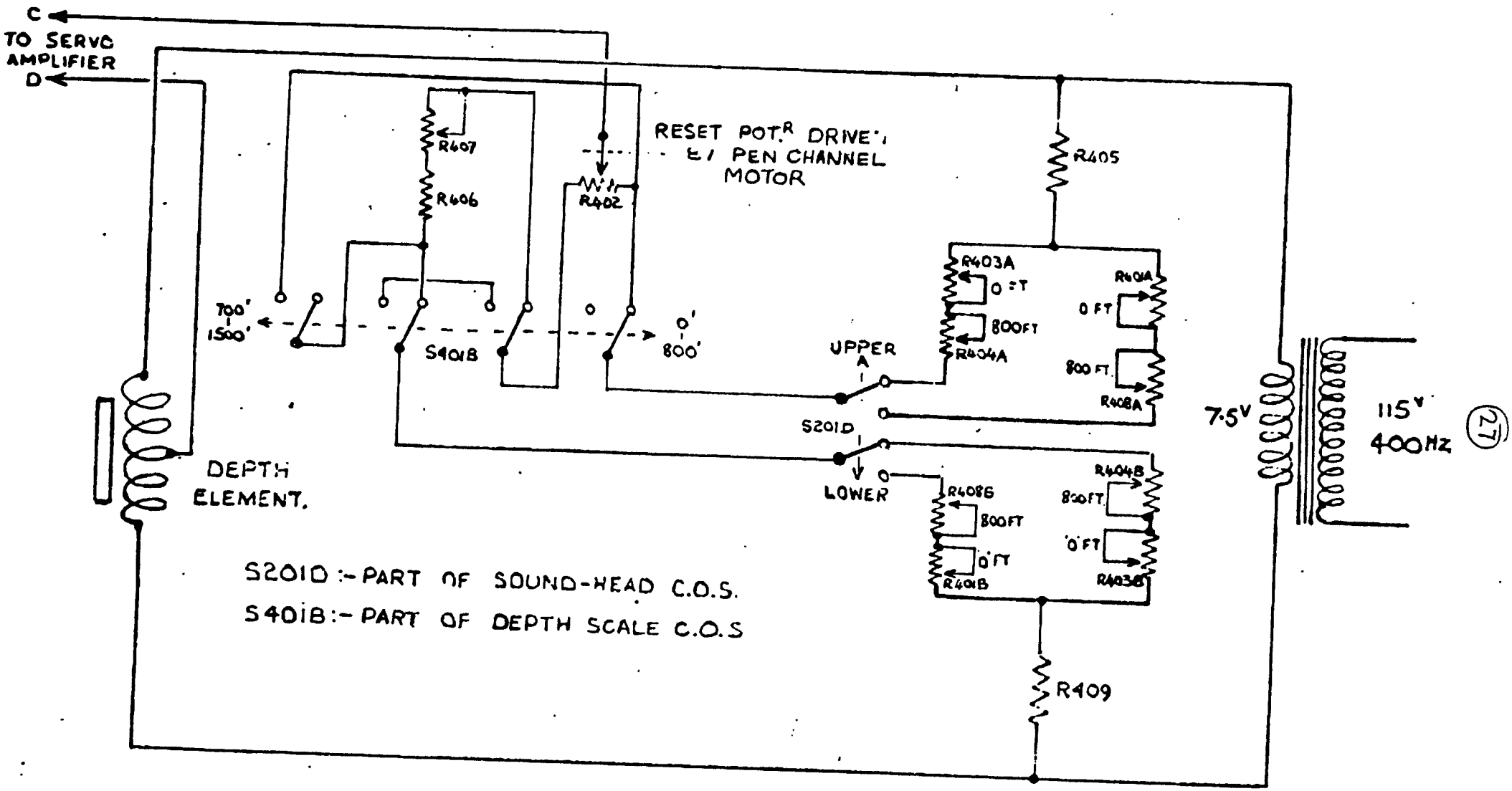


SONAR TYPE 2004

DEPTH ELEMENT SIMPLIFIED SCHEMATIC



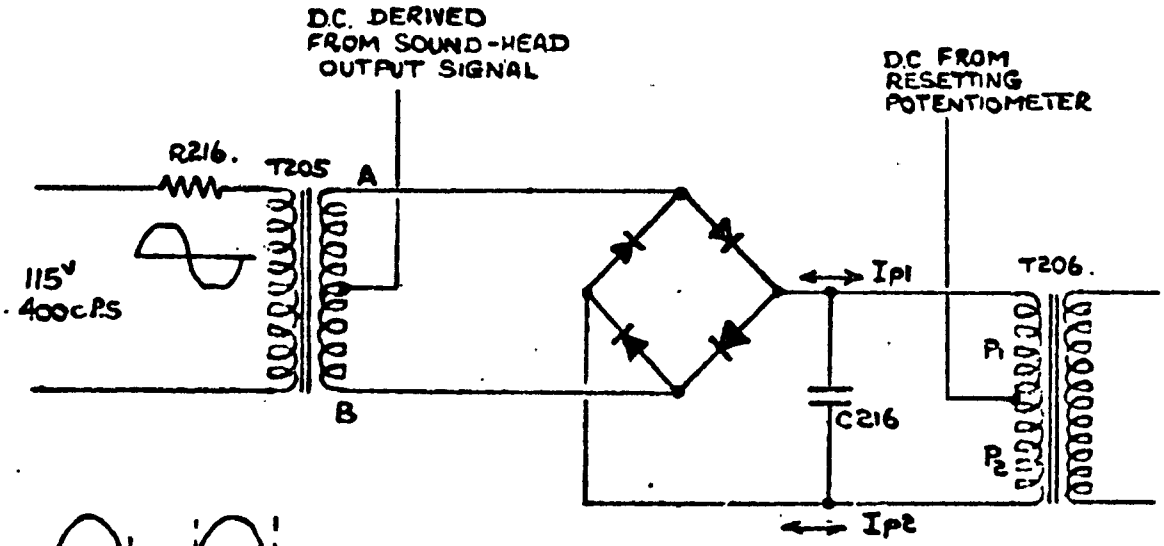
RESTRICTED

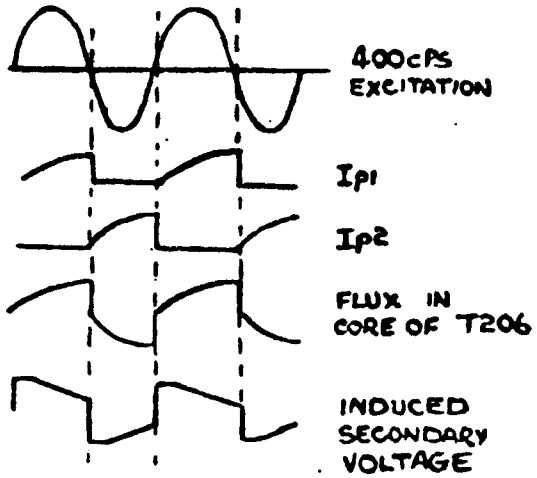


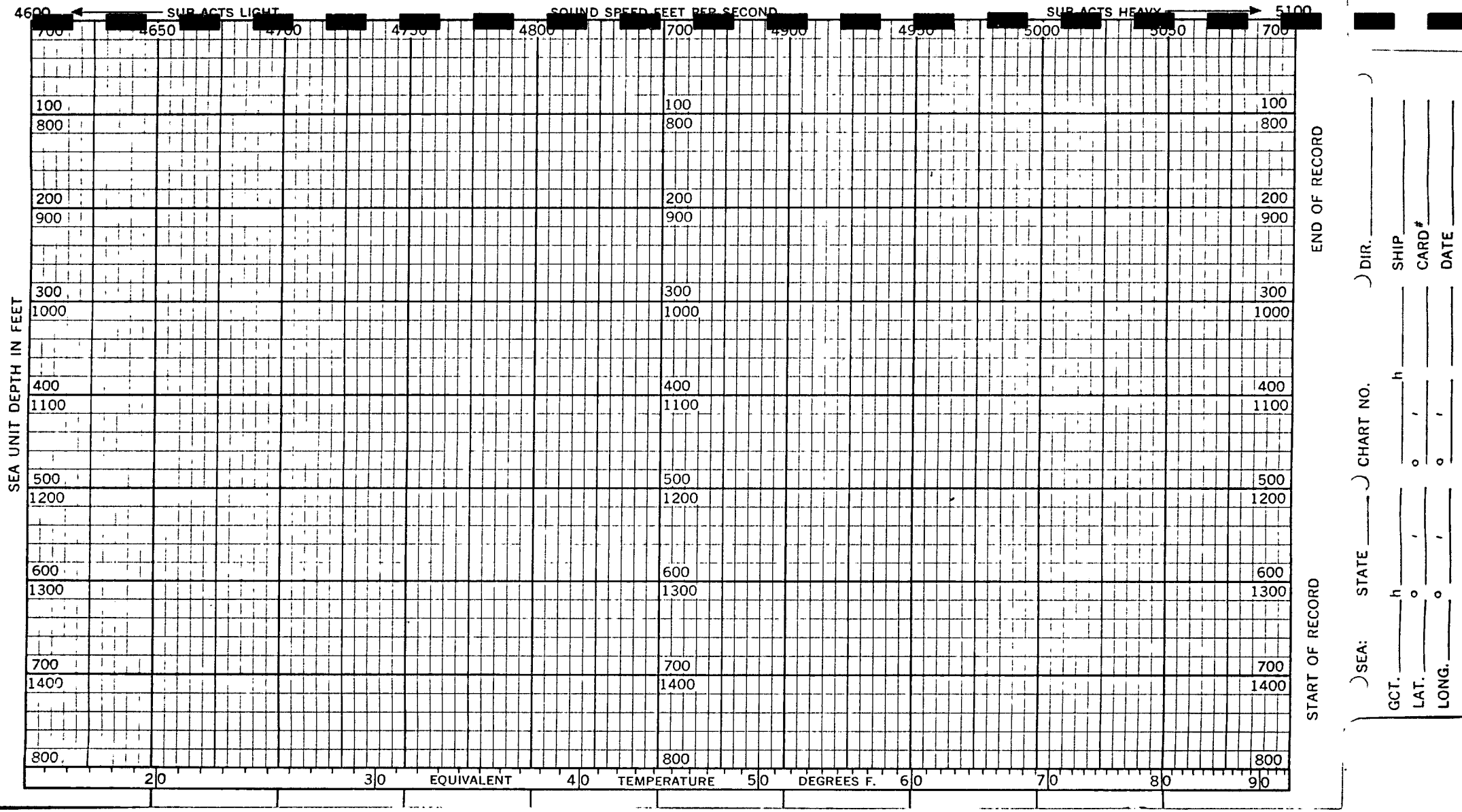
SONAR TYPE 2004. DEPTH CIRCUIT.

RESTRICTED

SONAR TYPE 2004.— MODULATOR OPERATION



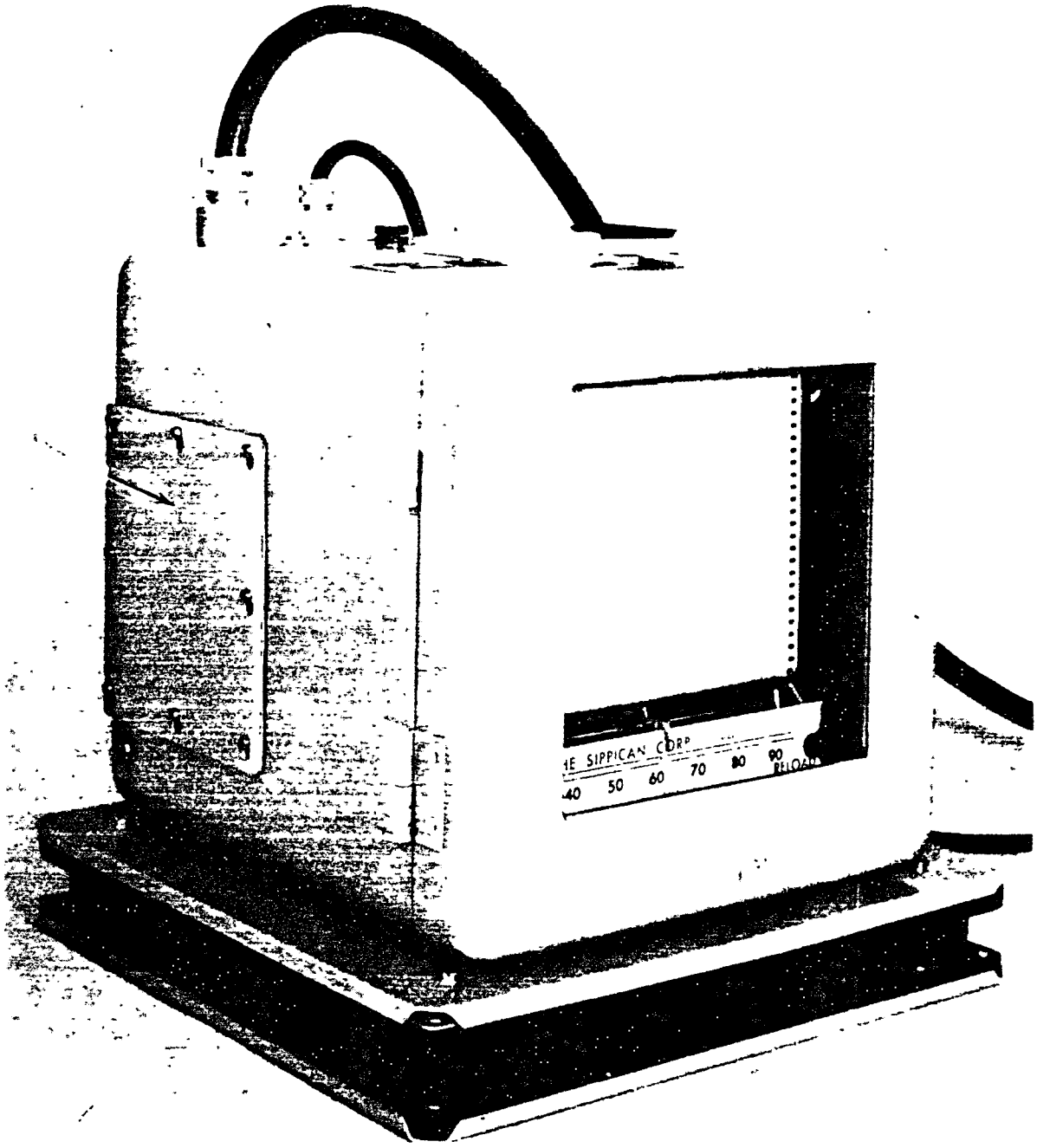




2004 RECORDER CARD

(31)

SUBMARINE EXPENDABLE BATHYTHERMOGRAPH SYSTEM (SSXBT)



S.S.X.B.T.

QUICK REFERENCE DATA.

POWER REQUIREMENTS..... 115v 60Hz.

TEMPERATURE SENSING RANGE.....28°F-96°F or -2°C-35°C.

TEMPERATURE ACCURACY..... ±0.4°F or ±0.2°C.

DEPTH RANGE..... 0 to 2500 FEET.

DEPTH ACCURACY..... ±2% or 15 Ft. WHICHEVER IS GREATER.

RECORDING TIME.....APPROX. 178 SECONDS FOR 2500 FEET.

LAUNCHING DEPTH..... 1,000 FEET MAXIMUM.

HANDBOOK.....TEM 6655 0001-1.

SUBMARINE EXPENDABLE BATHYTHERMOGRAPH

GENERAL INFORMATION

The Submarine Bathythermograph or SSXBT measures the temperature profile down to 2500 ft. in 180 seconds with little effect on the submarines manuvering.

The set consists of :(1) Expendable Bathythermograph devices.
(2) Breech door and cable feed thru mounted on the aft SSE.
(3) Connector box for wire connection.
(4) Recorder.
(5) Dummy load for system test.

DESCRIPTION OF UNITS

PROBE

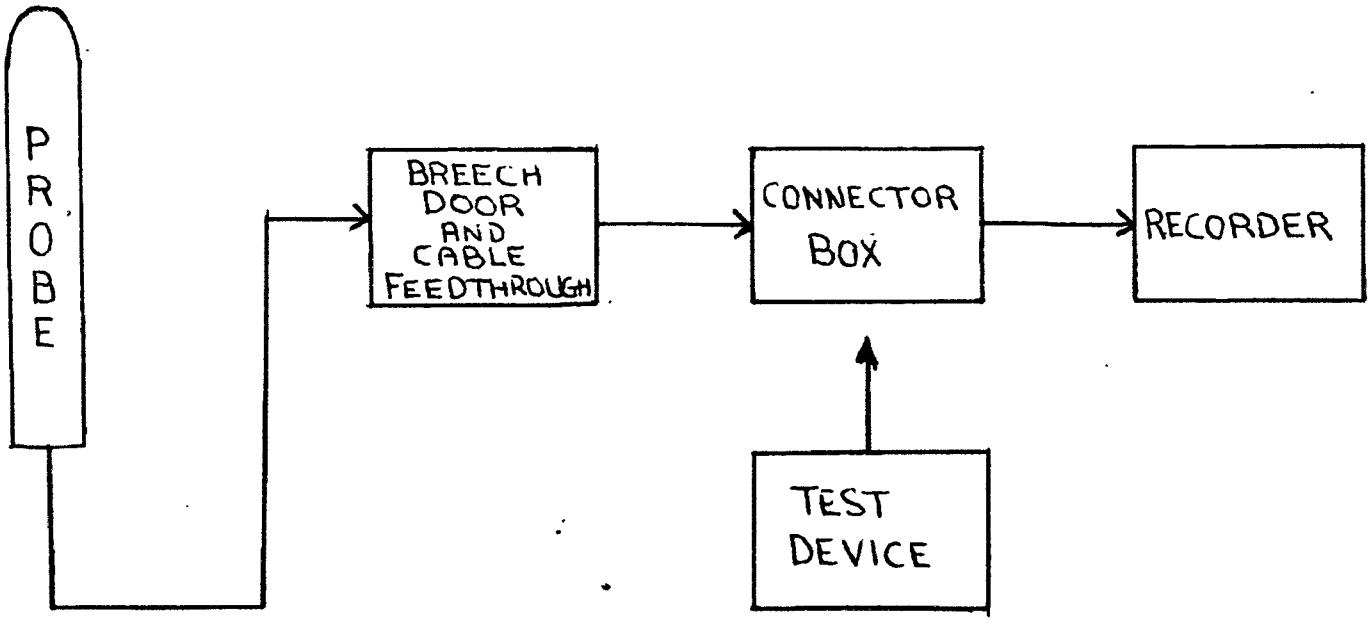
The SSXBT probe is contained in a bouyant float assembly. The float also contains the lifting body. When the SSXBT is launched, the lifting body is separated from the float assembly, and tethered to the submarine by a twin conductor steel wire. The lifting body goes behind the SSE, on the twim cable. The float rises to the surface when the absence of pressure releases the probe for its trip to the bottom. The probe contains a temperature sensitive device and the temperature is relayed to the recorder. The probe is weighted and stabilized to assure accurate velocity profile. When the probe is released, a sea water return circuit triggers the recorder measurement. The recorder plots temperature on the horizontal axis of the vertically driven paper. Since the rate of desent is known, depth can be read directly from the vertical scale on the chart paper. After passing 2500 feet, the probe exhausts its wire and sinks to the bottom.

BREECH DOOR AND CABLE FEED THRU

Insures watertight integrity, yet passes a two conductor wire into the submarine. Tether wire is then connected via the connector box to thr Recorder. Cable feed-thru consists of a small arifue and gland nut assembly to tightly seal a rubber grommet around the tether wire. A wire grip secures the tether wire to the SSE and a shear to sever the wire on completion of the measurement.

CONNECTOR BOX

Ensures a reliable electrical connection to the SSXBT tether wire and provides visual indication of system status. With lever in the reload position, the tether wire can be inseted thru the bottom and viewed through the front. With the lever to the LAUNCH position polarity correct connection is made to the tether wire. Connector Box status lamps indicate system readiness to RELOAD or LAUNCH SSXBT.



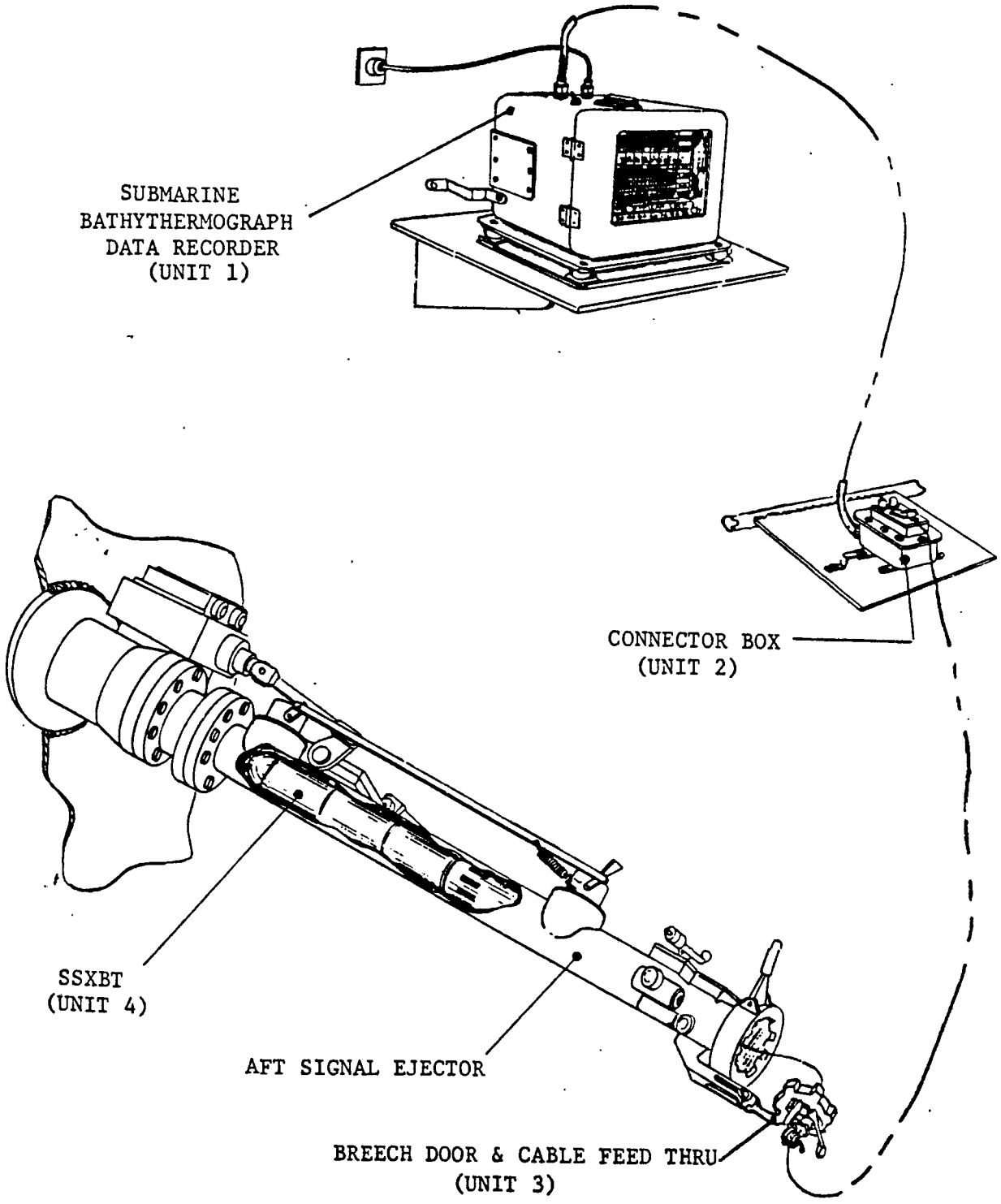
OPERATION

The SSXBT probe is fired from the aft SSE. The lifting body which is connected to the Submarine by an insulated, two conductor, steel wire, separates from the float assembly. The lifting body lies behind the SSE. It allows the fine wire cable to peel off a spool to counteract the submarines forward motion, and allows the float assembly to rise independantly of the effects of the submarines movement. The float assembly also holds a spool of the fine wire which dereels as required by the assent rate of the float assembly as it rises to the surface. When the float assembly reaches the surface atmospheric pressure acuates a pressure release mechanism. This releases the probe for its desent. On release a seawater return circuit is completed which triggers the recorder movement. The varing temperature of the water as the probe sinks causes the resistance of the thermister to vary. By using the seawater as a return circuit and the fine wire connected to the recorder, the temperature profile is ploted on the recorder.

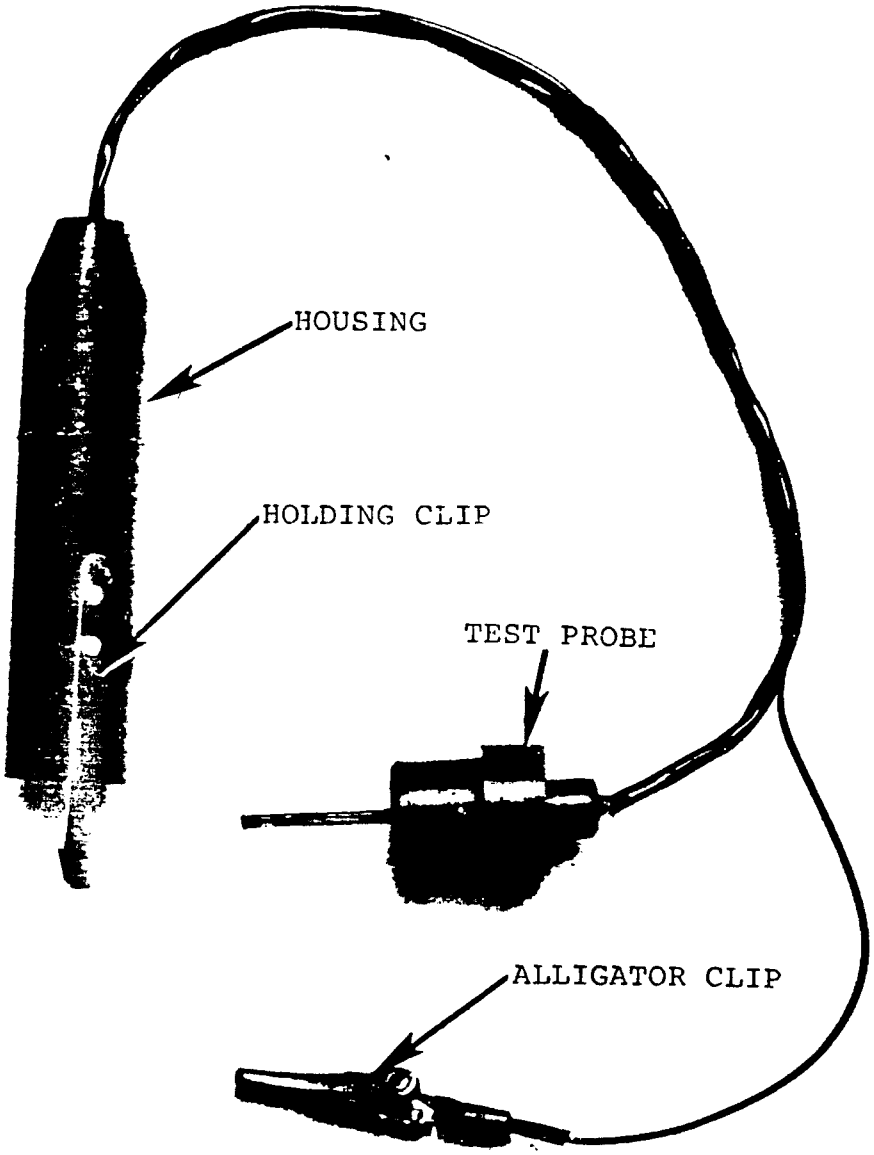
THE MAJOR UNITS ARE:

(1) STATUS INDICATOR LAMPS: Status indicator lamps are mounted to the left and right ends of the temperature scale. They indicate system RELOAD and LAUNCH.
(2) TEST PANEL: Test panel is located at the right hand end of the temperature scale. The 94° - 30° permits calibration checks in conjunction with the TEST DEVICE.
(3) TRIGGER DELAY CIRCIUT: During the LAUNCH mode, the trigger delay prevents the recorder from false triggering due to SSE flooding, or other conditions. In the MEASURE mode, the chart drive is delayed 1.3 sec. to permit probe exit, and assure accurate depth scale.
(4) CHART DRIVE: Powered by a timing motor, the chart drive precisely controls chart speed independant of voltage or frequency variations. 12" of paper is used for each XBT.
(5) BRIDGE TRIGGER LOGIC AND POWER SUPPLY: The bridge circuit monitors thermister resistance and directs a temperature dependant signal to temperature servo. It is supplied by a controlled current source, in order to minimize the effect of sea-water and wire resistance. The trigger logic sequences recorder through 4 modes. They are: (1) LAUNCH MODE
(2) CHECK/RUN MODE
(3) MEASURE MODE
(4) RELOAD MODE

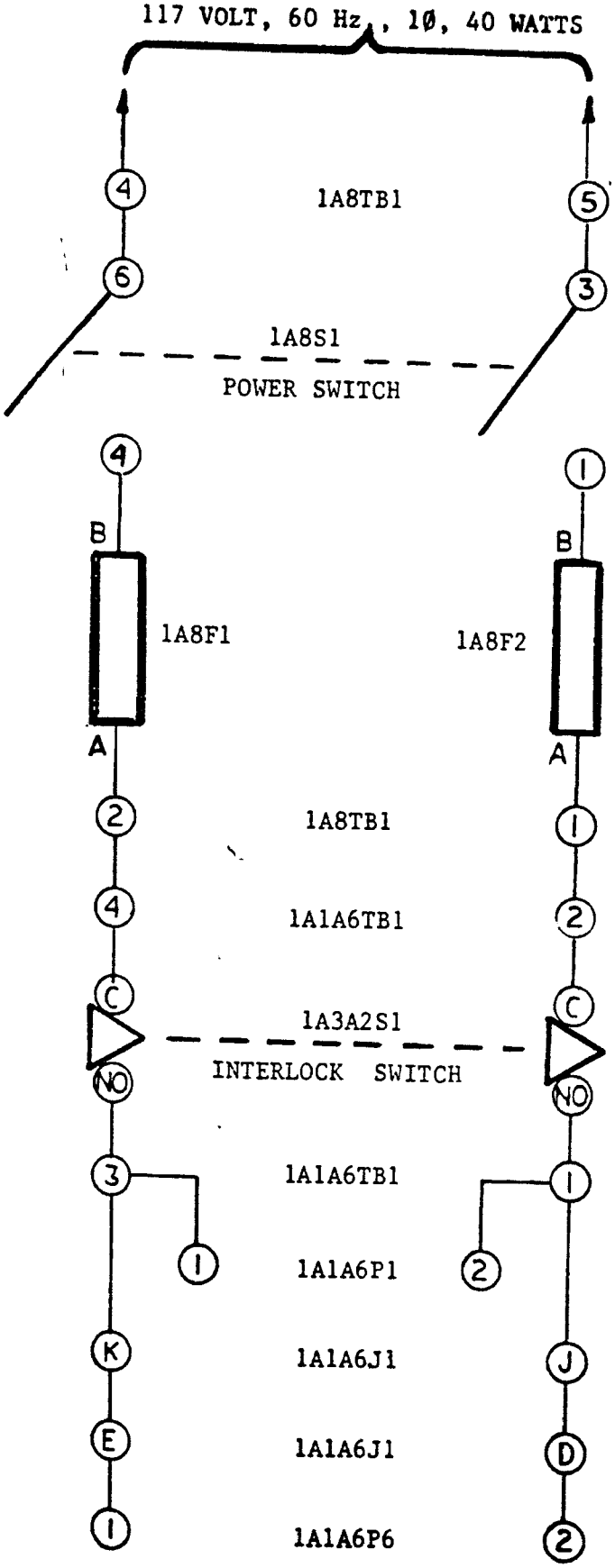
The power supply produces D.C. voltages for bridge, trigger logic, chart drive and status indicators.
(6) TEMPERATURE SERVO: The temperature servo consists of a servo amplifier, servo motor and a servo potentiometer. The amplifier boosts low level bridge signals and drives a two phase motor to horizontally position the chart paper stylus. Chart paper is 7" wide and is equal to a temperature range of 28° to 96°. The servo potentiometer monitors the chart stylus position and transmits a position signal back to the bridge circuit, closing the servo feedback loop.
(7) MULTICYCLE CIRCUIT: The multicycle circuit controls the measure mode chart drive duration.



SUBMARINE BATHYTHERMOGRAPH SET
RELATIONSHIP OF UNITS



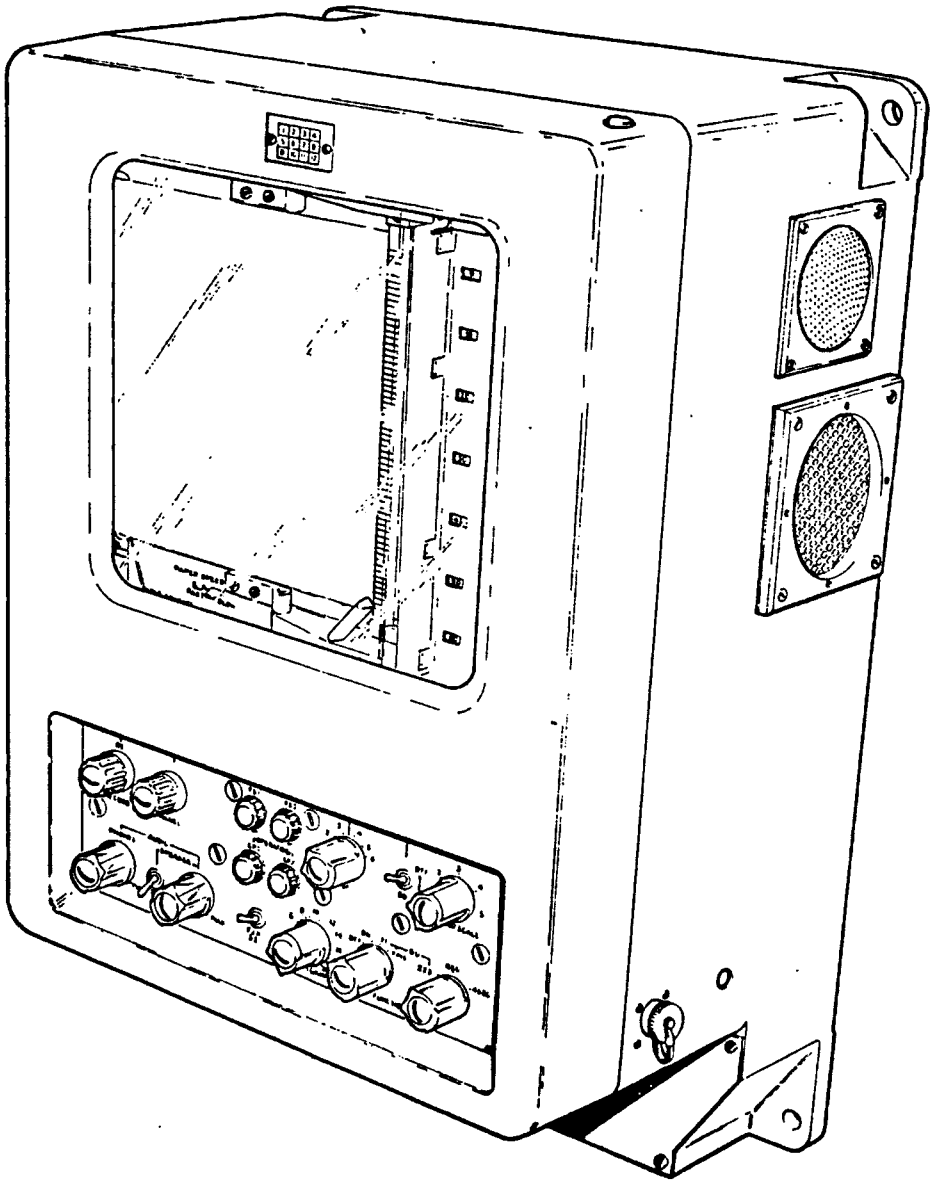
Test Device



Recorder Power Distribution Diagram

ECHO SOUNDER TYPE 778

GENERAL SERVICE DEPTH RECORDER



GENERAL INFORMATION FOR E/S 778.

GENERAL SERVICE DEPTH RECORDER (GSDR).

Power Supplies:
115V ± 10% , 55Hz ± 6.5 Hz.

Depth Velocity:
Either 4800 or 4920 feet/second.

Depth Range :
2 to 4500 fathoms in three ranges.

TRANSMITTER:

Frequency :
10KHz.

Pulse Width :
1ms on the 225 fathom range.
5ms on the 450 or the 4500 range.

Power :
300 watts maximum. 0 to 50db attenuation in 10db steps.

BRIDGE UNIT (BU).

Power Supplies:
Same as GSDR.

Depth Velocity:
4920 feet/second.

Depth Range :
6 to 99 feet or 2 to 99 fathoms.

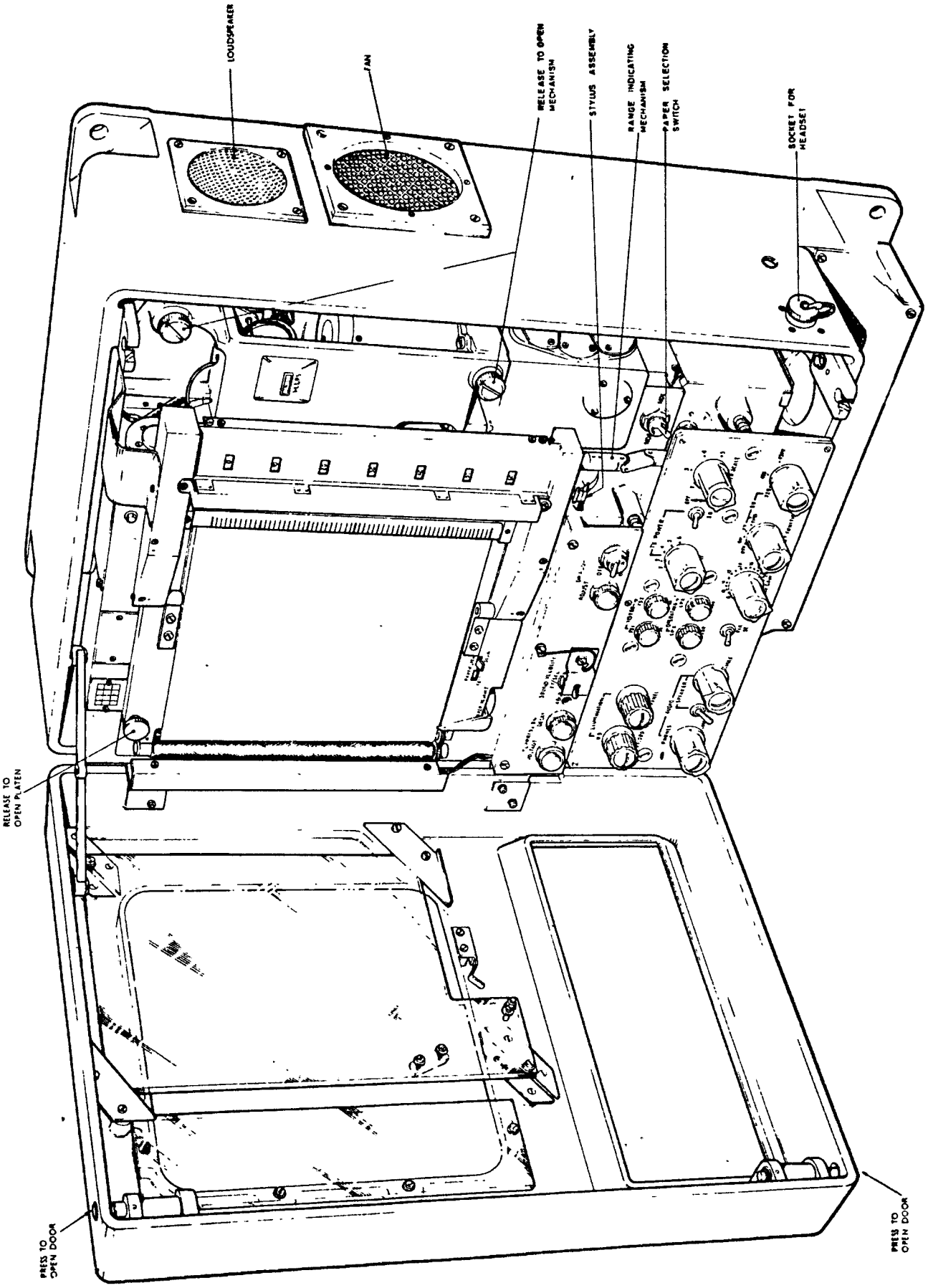
TRANSMITTER:

Frequency :
48KHz nominal.

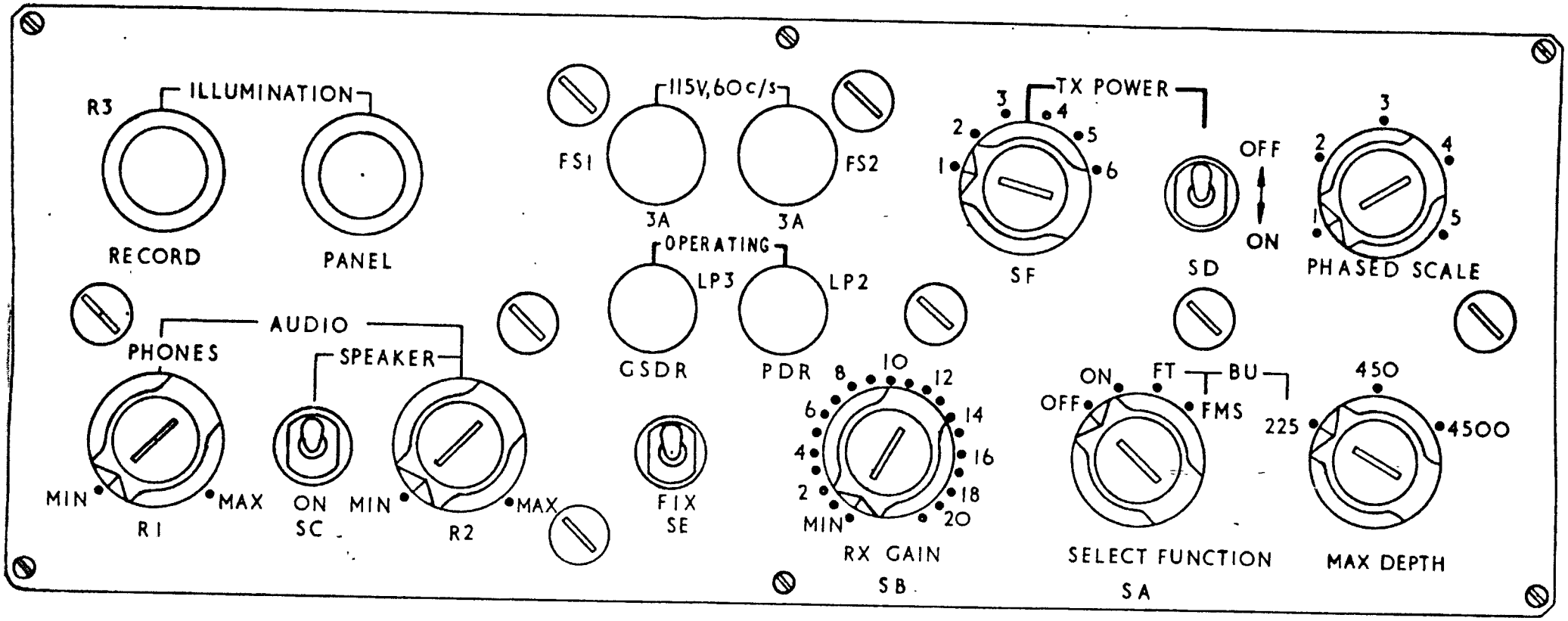
Pulse Width :
200us on "feet" range.
500us on "fathom" range.

Power :
10 watts on feet; 50 watts on fathoms.

HANDBOOKS - BR 2800(1) - PART 1
BR 2800(2) - PART 2
BR 2800(3) - PART 3A, 3B, 3C, 5.
BR 2800(4) - PART 6.



FRONT VIEW OF G.S.D.R.



CONTROL PANEL

GENERAL PURPOSE ECHO SOUNDER TYPE 778

SUBMARINE VARIANT

The equipment consists of two interconnected Echo Sounding sets capable of independant operation. They are:

1. A Medium/Deep Navigation set comprising a General Service Depth Recorder (GSDR) and a Medium/Deep Transducer. Together they produce a permanent analogue record of depth to a maximum of 4,500 fathoms.

2. A Command instrument termed the Bridge Unit (BU) comprising a VCS type display, receiver/transmitter and a shallow sounding transducer. They produce a digital readout of depth to a maximum of 99 fathoms, and if required an analogue record can also be produced on the GSDR of the Medium/Deep equipment.

GENERAL SERVICE DEPTH RECORDER

This is a fully transistorised, repair by replacement unit

The trace display is a true profile picture in that the transmission mark is at the top of the trace, and the echo is at the bottom. The recording paper, which is 8 inches wide and of the dry variety, is moved from right to left across the front of the recorder. The stylus which is mounted on a pulley driven belt, moves from the top to the bottom of the chart.

The depth scales and phases for the recorder as shown in Table 1.

Scale Phase	225 fms	450	4500	Phase Marker Pos.
1	0-60	0-120	0-1200	Tx Mark
2	45-105	90-210	900-2100	Below 1st Depth Mark
3	90-150	180-300	1800-3000	Below 2nd Depth Mark
4	135-195	270-390	2700-3900	Below 3rd Depth Mark
5	180-225	360-450	3600-4500	Tx Mark near trace bottom

Depth Marker lines are displayed at 5, 10 and 100 ftms in the respective ranges to assist in depth measurement.

General Purpose Echo Sounder Type 778 - (contd)

The trace can be adjusted for two different speeds of sound in water ie. 4800 ft/sec and 4920 ft/sec. These speeds are indicated on the trace by a dotted line above the Tx mark when switched to 4800 ft/sec. The space is blank when in 4920 ft/sec.

TECHNICAL DESCRIPTION - TRANSMISSION

Two crystal oscillators produce frequencies of 20.992 KHz and 20.48 KHz. These frequencies are used to represent the two speeds of sound in water. The required frequency is selected by the sound velocity switch and fed into a divide by 256 circuit. This circuit output is used to produce the 5 fathom depth markers. The output can be further divided to produce the 10 fathom markers. These marker pulses are fed away to:

1. The depth marker generator (external).

2. Divide by 10 circuit (internal) which produces the 100 fathom marks.

3. And via the circuit below as a trigger initiation for transmission.

The selected frequency is also fed directly to the Motor Drive Amplifier w where it is fed into 3 integrator circuits, the outputs of which feed 3 J-K bistables connected by feedback. These produce a 3 phase square wave output which drives a synchronous motor connected to the stylus drive. When the 4500 fathom range is selected two of the three phases are transposed to reverse the motor rotation which then drives the stylus assembly, through gearing at a slower speed. The motor belt also drives a magnetic shutter which is notched to allow the contacts of a reed switch to be closed by the action of a permanent magnet once per cycle of the shutter. The switch operates 5 times per revolution of the belt.

The re-opening of the reed switch contacts, which is co-incident with the trailing edge of the shutter aperture, provides a triggering signal. This signal is summed with the signal produced by an encoder which contains 5 earthed contacts which can be individually selected by the phase switch. Each contact is open circuit during a different arc of rotation of the encoder to provide a "window" for each of the 5 operations of the reed switch. The summed signal provides the trigger signal to initiate the transmission.

The trigger signal is fed to the Depth Marker Generator where it switches on a multivibrator. The step output is passed to the Gating circuit of the Echo Sounding Transmitter and allows the 10 KHz transmission pulse to pass to the transducer via the Power Output switch. The pulse length of the transmission pulse is controlled by the Gating Circuit.

General Purpose Echo Sounder Type 778 - (contd)

RECEPTION

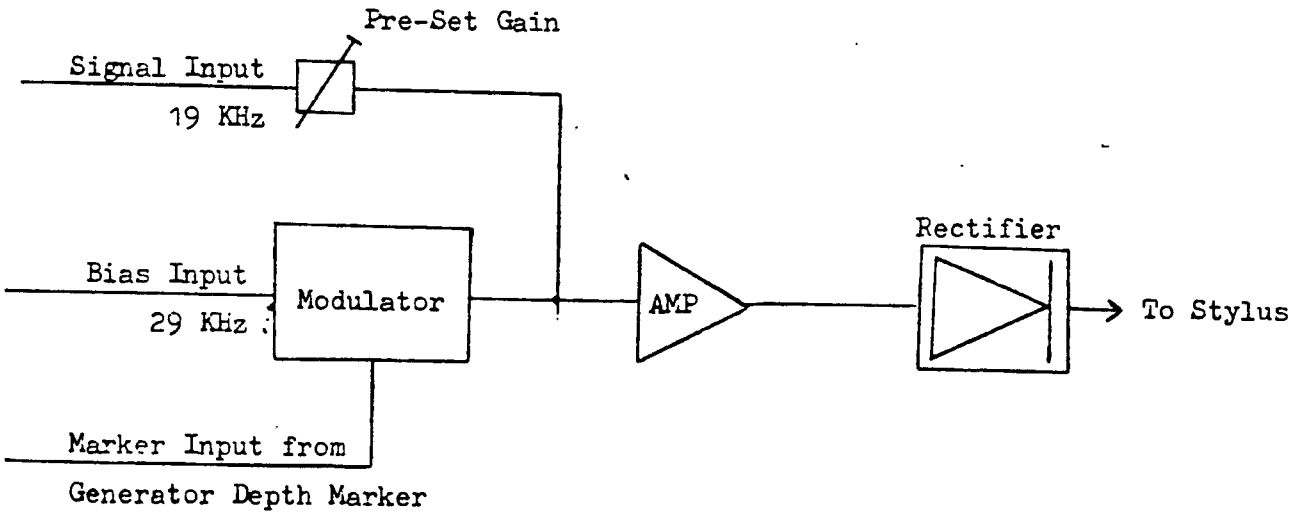
The transmitted signal is also passed to the Initial Reverberation Suppressor where it is rectified and passed to an Emitter Folower. The resultant negative voltage pulse, the duration of which is equal to the transmission period, is passed to the Receiver Pre-Amplifier. The Pre-Amplifier contains the transmit/receive switch which short circuits its tuned amplifier during the transmission pulse, thus protecting the receiver circuits. Also included in this circuit is a system of Time Varying Gain whereby the suppression pulse is fed to the Tuned Amp to reduce its gain to a minimum during the transmission period. During reception the gain rises exponentially thus giving greater amplification to echos from greater depths.

When an echo is received it passes through the tuned amplifier to the Receiver Gain Control in the Echo Sounding Amplifier. Here it is filtered through a 2 KHz bandwidth filter when in the 225 fathom range (250 Hz bandwidth filter is used in the other two ranges). The signal is amplified by approximately 90 db's and passed to the:

1. Echo signal modulator.

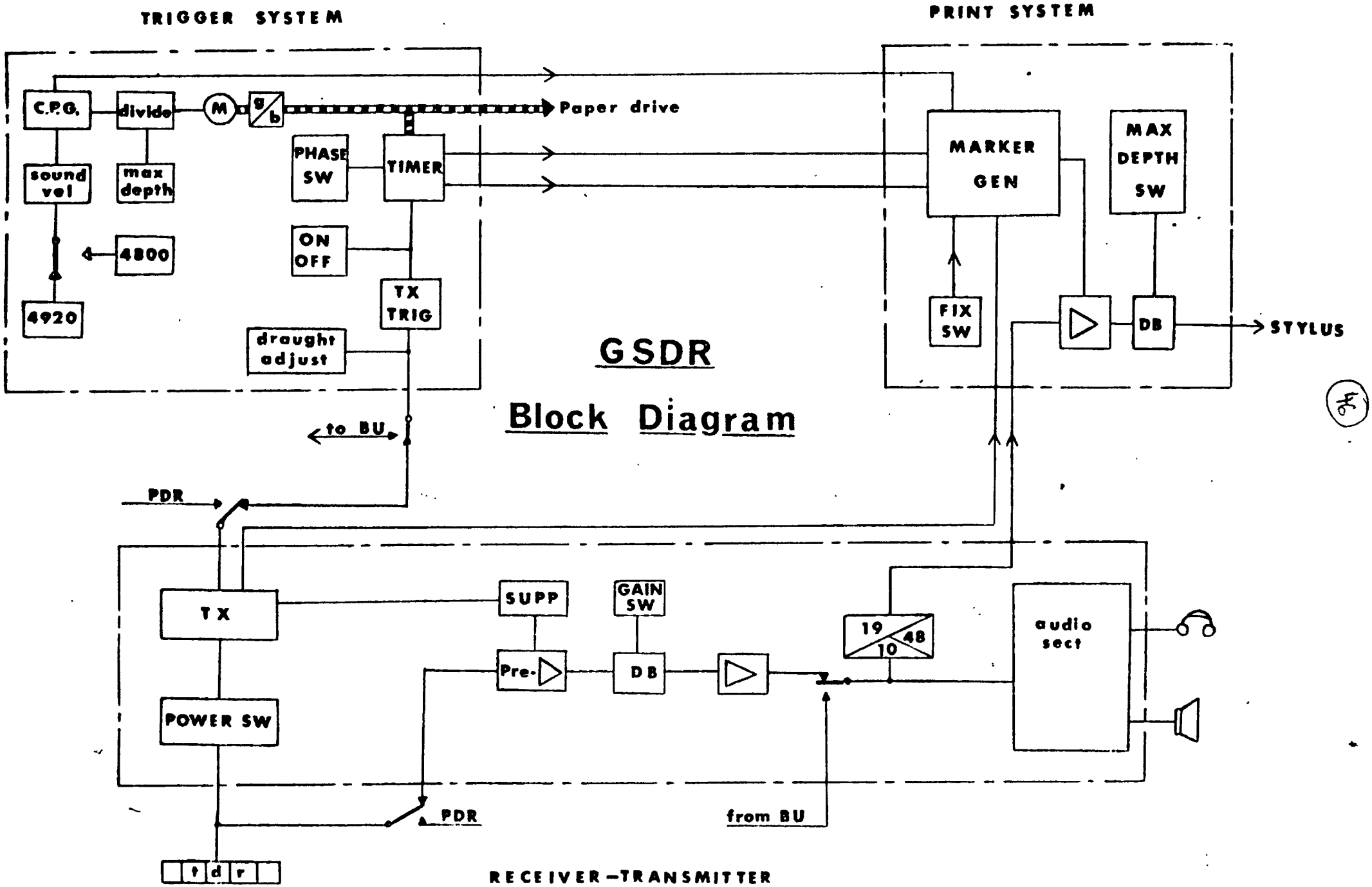
2. Audio amplifier.

The signal passed to the Echo Sounder Modulator is processed as shown below:



The signal input (19 KHz) is produced by hetrodyning the Transmission Signal with 29 KHz in the Echo Sounder Modulator.

An audio output is produced by down hetrodyning the 10 KHz echo in the audio amplifier and feeding the 1 KHz note to the loudspeaker and the headphone socket via a volume control.


TRIGGER SYSTEM
PRINT SYSTEM
C.P.G.
divide
M
g/b
Paper drive
sound vel
max depth
PHASE SW
TIMER
MARKER GEN
MAX DEPTH SW
4800
ON OFF
4920
TX TRIG
FIX SW
DB
STYLUS
draught adjust
GSDR
Block Diagram
to BU
PDR
TX
SUPP
GAIN SW
19/48
10
audio sect
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POWER SW
PDR
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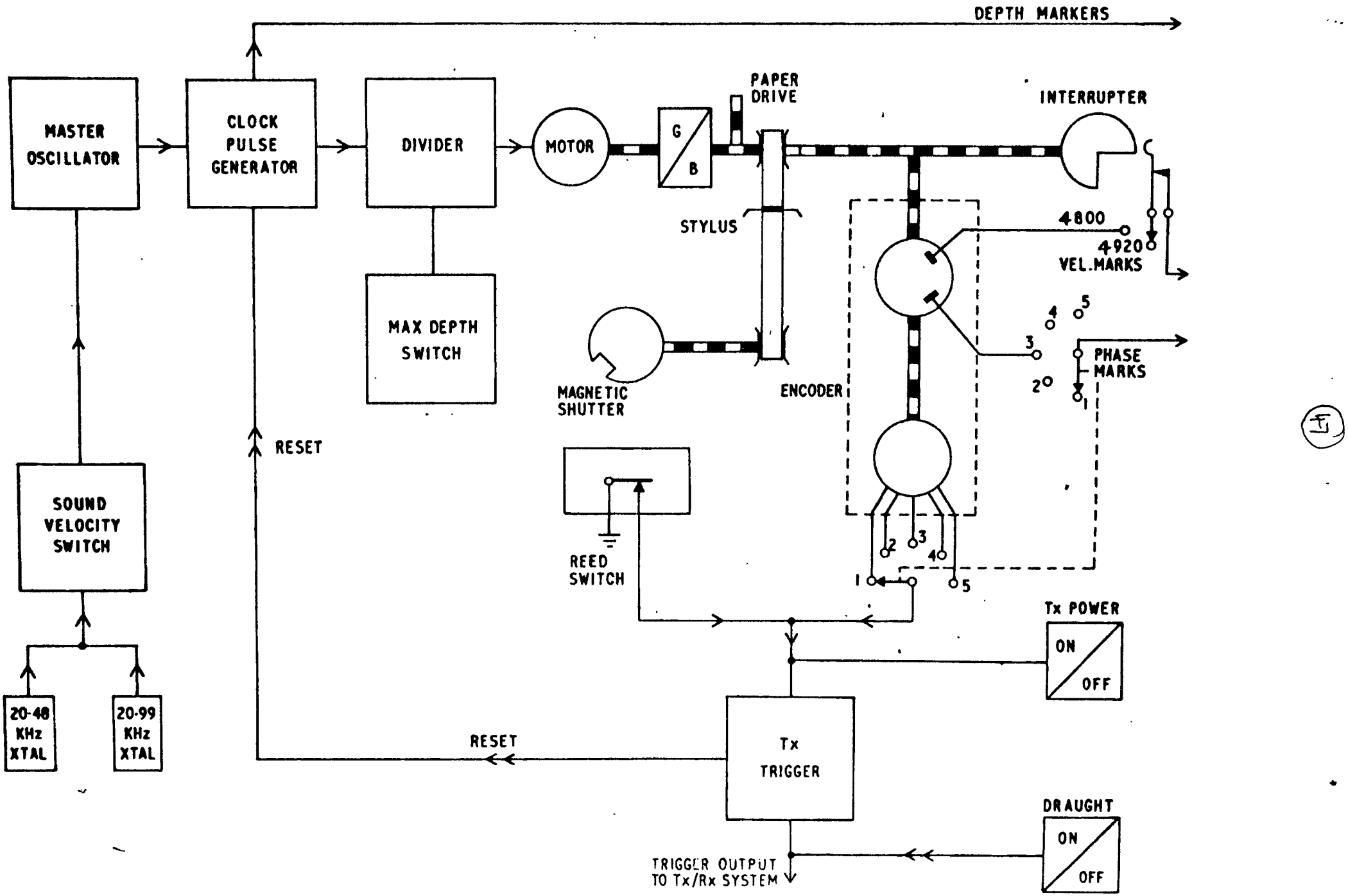
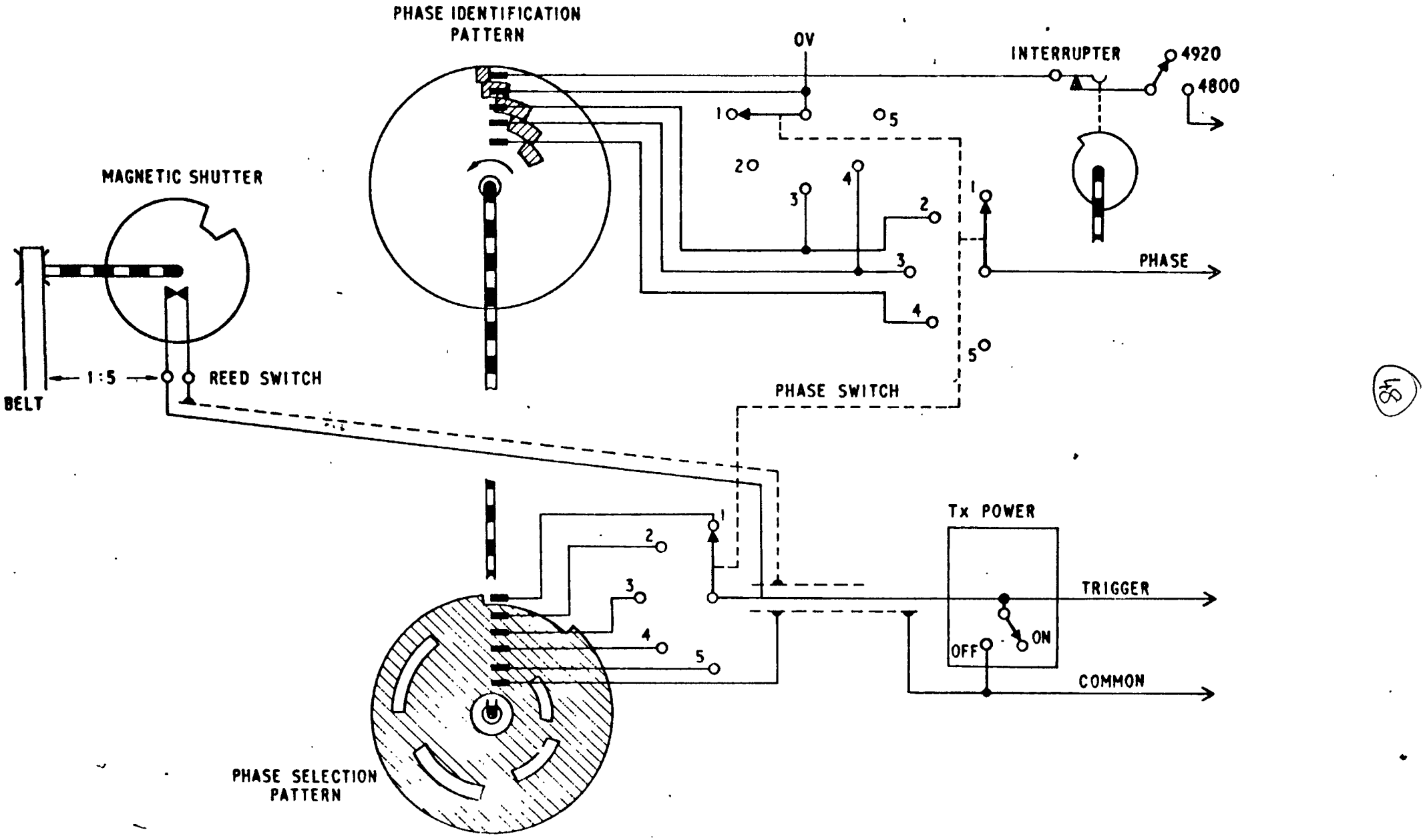
RECEIVER-TRANSMITTER

778 TRANSMITTER TRIGGER

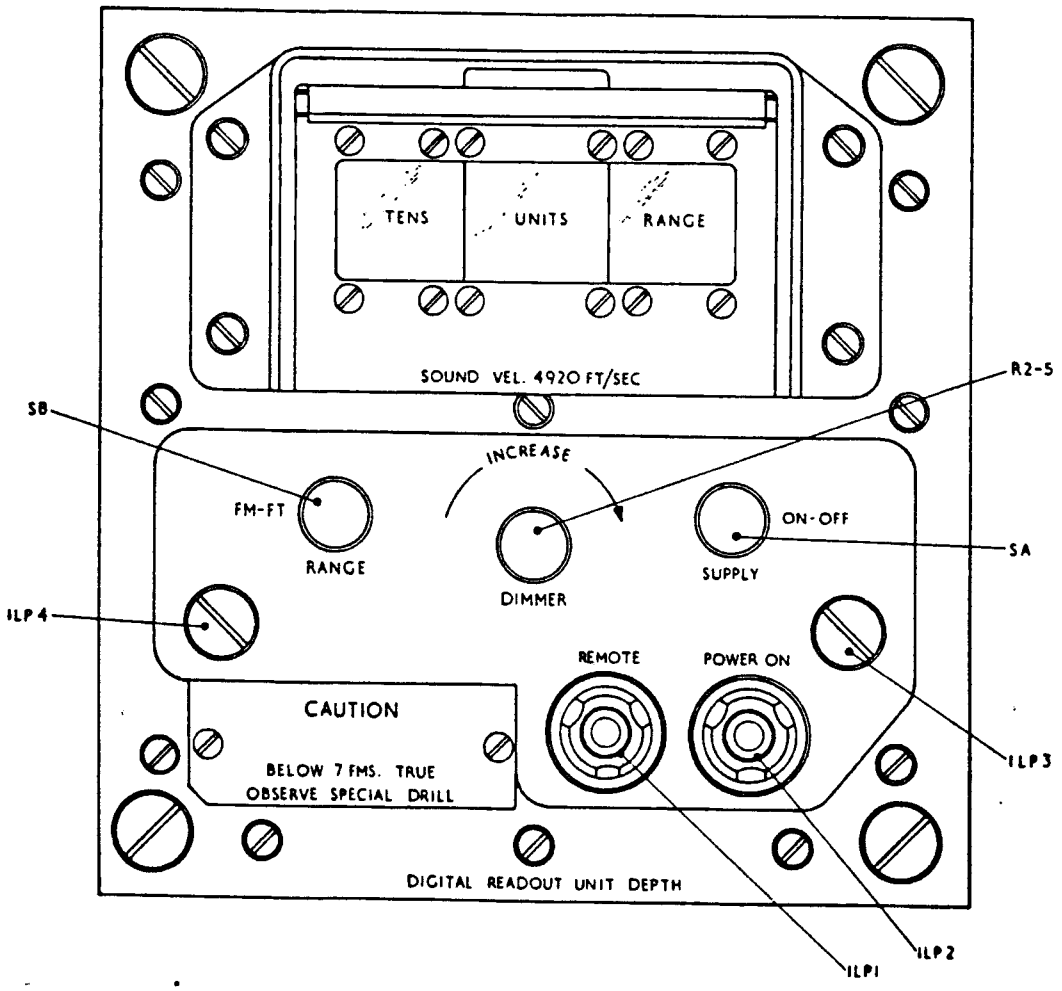


778 TRANSMITTER PHASING



ECHO SOUNDER TYPE 778

BRIDGE UNIT



THE BRIDGE UNIT

This unit comprises the receiver/Transmitter and the digital readout unit. The system is designed to provide a digital indication of depth from 6 feet to 99 fathoms. It can be operated independantly of the GSDR without interference, or the GSDR may be switched to record the Bridge Unit echo signals to a depth of 225 fathoms. The equipment operates for a set speed of sound in water of 4920 feet/sec, at a frequency of 48 KHz.

TECHNICAL DESCRIPTION - TRANSMISSION

A trigger input, which is produced in the receiver/transmitter, is shaped to produce a display blanking pulse which is used to:

1. Trigger the transmitter.
2. Provide initial reverberation suppression.
3. Provide initial timing for:
   a. Minimum depth system.
   b. Time gate.
   c. AGC system.

To ensure that the receiver is inhibited before a transmission can occur, the blanking pulse is delayed by 100 μ sec, before it is fed to the transmitter, and also the digital readout unit, as a start pulse. The transmission is produced by gating a 48 KHz oscillator 'ON' for either 200 μ sec (feet range) or 500 μ sec (fathom range).

RECEPTION

A received echo signal is fed to the Echo Sounding Amplifier where it is amplified and outputs fed to:

1. The receiver gain equaliser.
2. The minimum depth amplifier.
3. The amplitude gate.
4. The GSDR.

General Purpose Echo Sounder Type 778 - (contd)

The echo signal is passed to the receiver gain equaliser where, if it is of sufficient amplitude, it triggers on AGC voltage which is immediately fed back to the echo sounding amplifier to reduce the gain by 6 db's. When the echo falls below its trigger level, the AGC voltage falls and allows a 3 db increase in receiver gain by the time the next echo pulse is due.

The echo signal is also fed to the minimum depth amplifier. If the depth is less than 6 ft circules are displayed on the digital display. If the depth is greater than 6 ft this part of the circuit is bypassed. The signal then passes to the amplitude gate where it is gated with the display blanking pulse to prevent a signal being passed during the transmission period. Provided the echo is of sufficient amplitude it will 'fire' a monostable which will feed the digital readout unit with a 'stop' pulse.

This stop pulse is fed back to the gate to prevent the receipt of multiple echos.

The blanking signal (start pulse), which was initially fed away to the Clock Pulse Generator, opens a gate at the instant of transmission. This gate opening allows pulses from a 2.4 KHz clock generator to pass to the counter. Once the echo is received a stop is fed to the gate which shuts, stopping the counter. Thus the gate is only open for the time period between the transmission and the echo. The pulses from the Clock Pulse Generator are 'counted' in the digital counter and displayed on a 2 digit screen. The third digit is used to display either FT or FMS depending on the range selected.

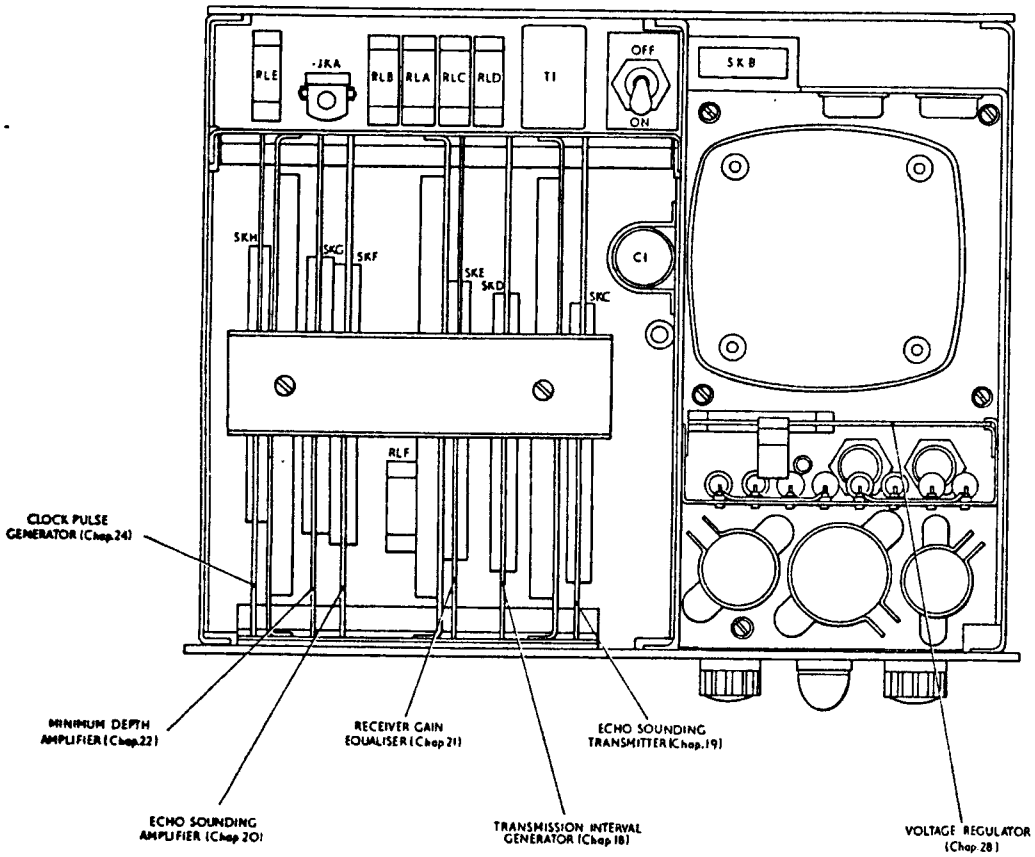
If the depth is below 99 ft or fathoms the Clock Pulse Generator will 'overcount' and pass a signal to the overcount circuit and cause the display to show crosses over the digits as an indication of too great a depth for the equipment.

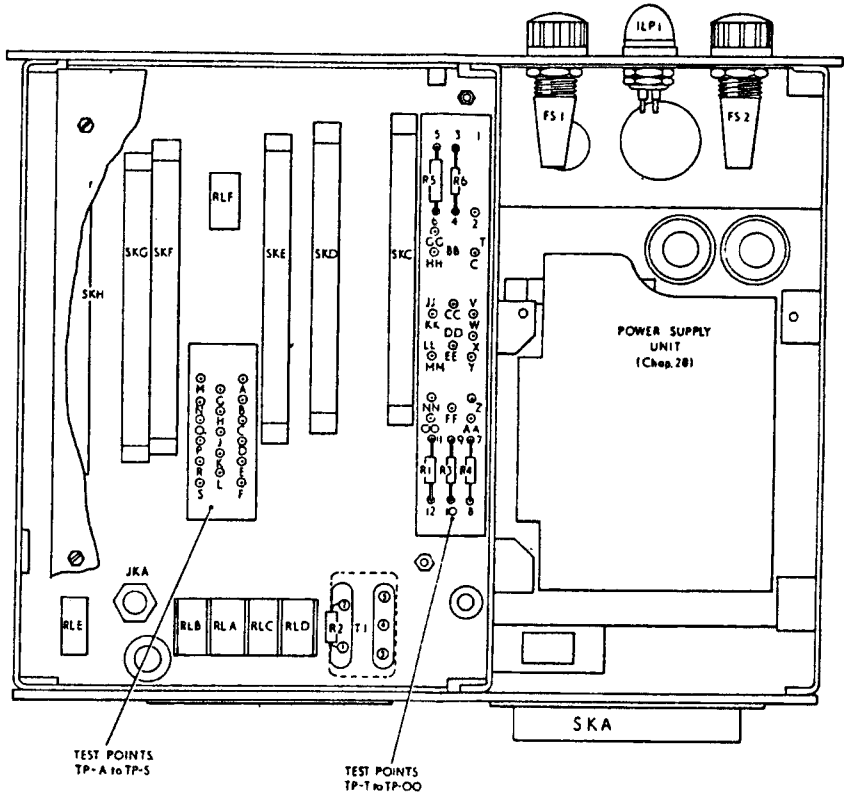
USE OF THE GSDR AND BU COMBINED

As well as using both sets indpendantly, they can be combined to form a shallow echo sounding unit giving both digital and analogue records. In order to do this the GSDR is siwtched to either FM or FMS(BU) and the depth scale to 225 fathoms. This will automatically put supplies onto the Bridge Unit. The GSDR will print the echos automatically in fathoms regardless of the scale shown on the digital readout unit. OR FEET

The transmission is initiated from the GSDR and, therefore, the transmission switch on the GSDR must be to ON. This allows the pulsed signal from the transmitter trigger in the GSDR to be sent to the transmission interval generator in the BU and the signal flow is then as for normal BU operation.

The received echo is passed from the echo sounding amplifier to the echo sounding modulator in the GSDR and then to the print system. To produce the 19 KHz signal in the print system the 48 KHz pulse is mixed with 29 KHz signal already present in the stylus drive amplifier.

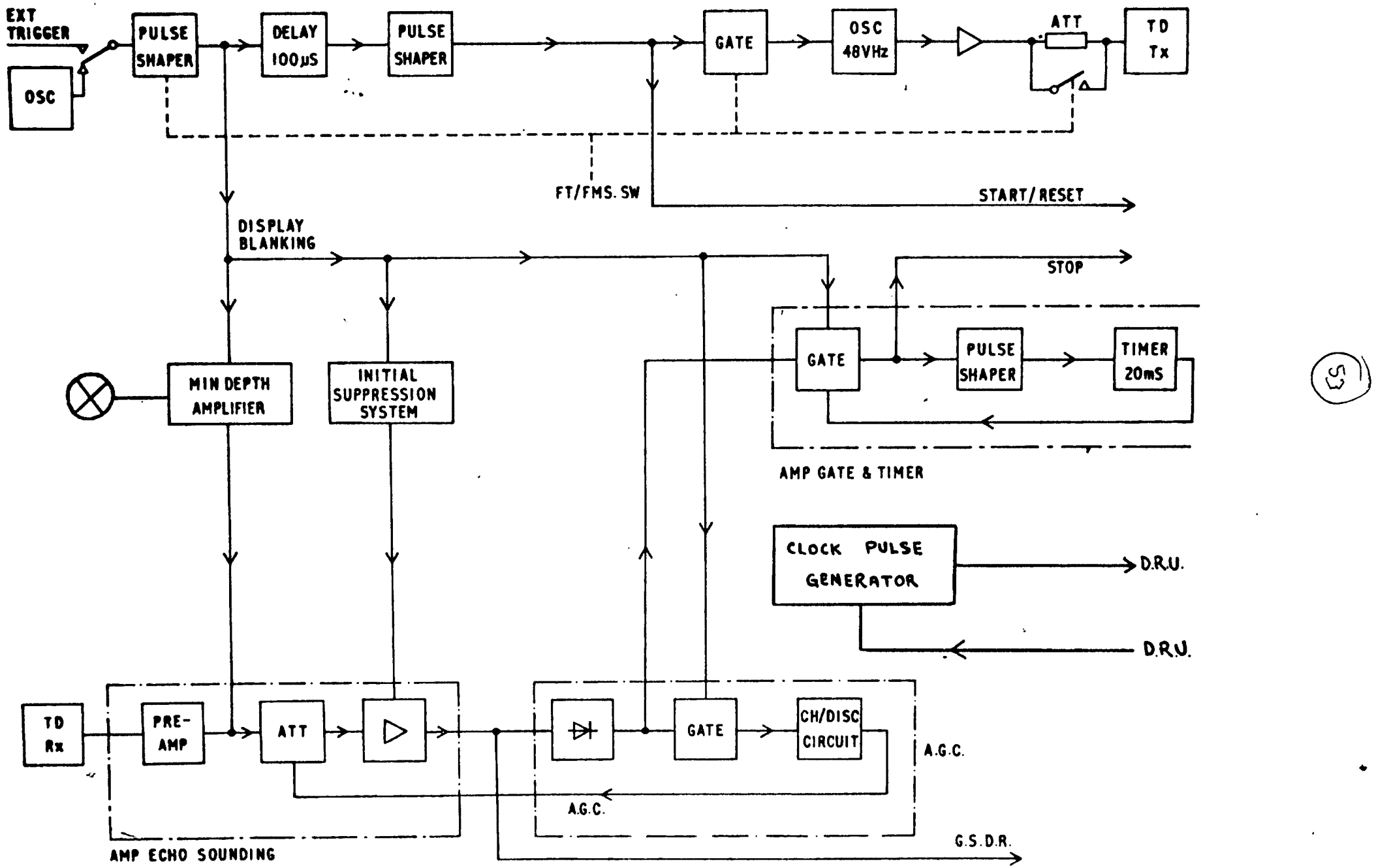




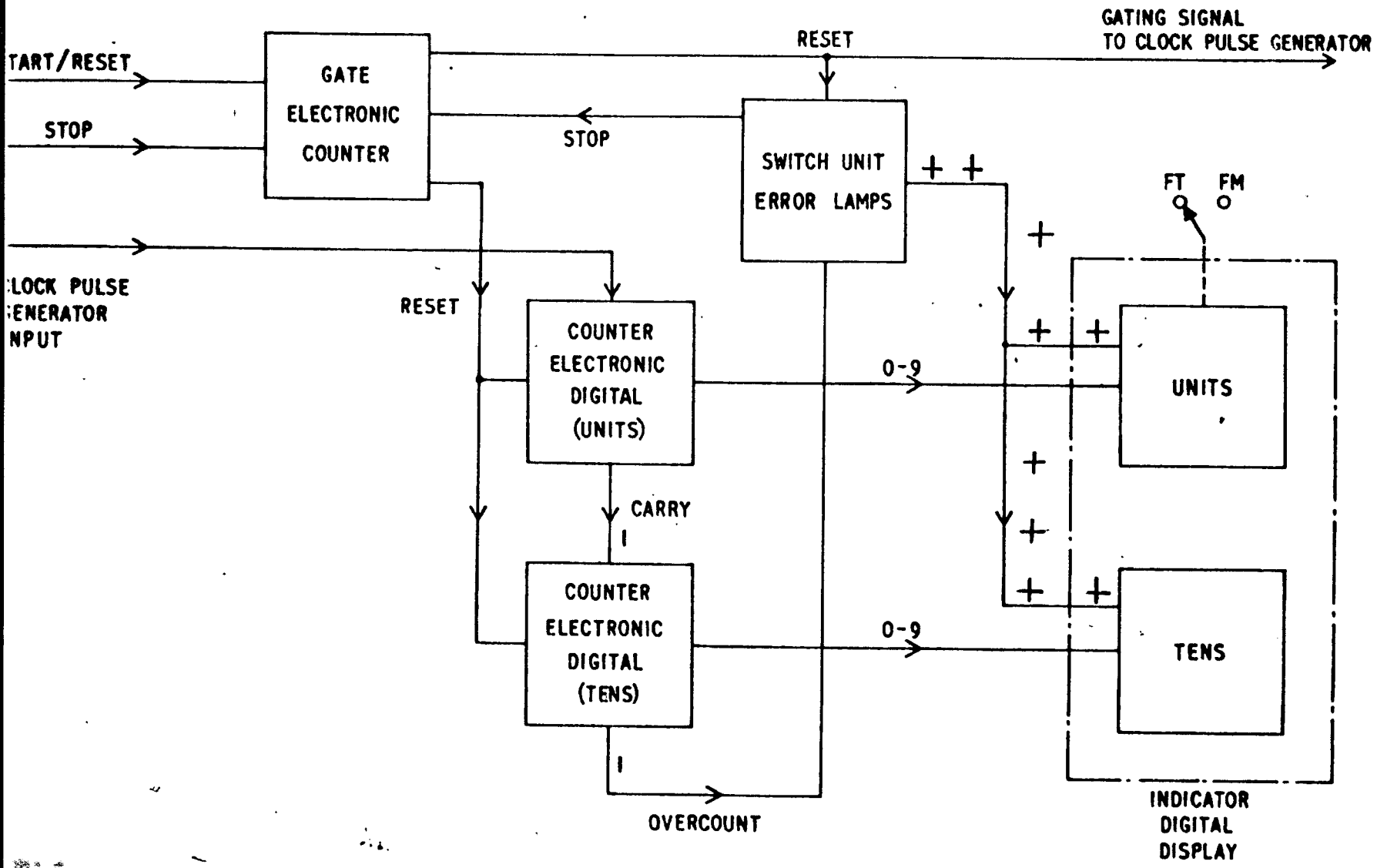
UNDERSIDE VIEW

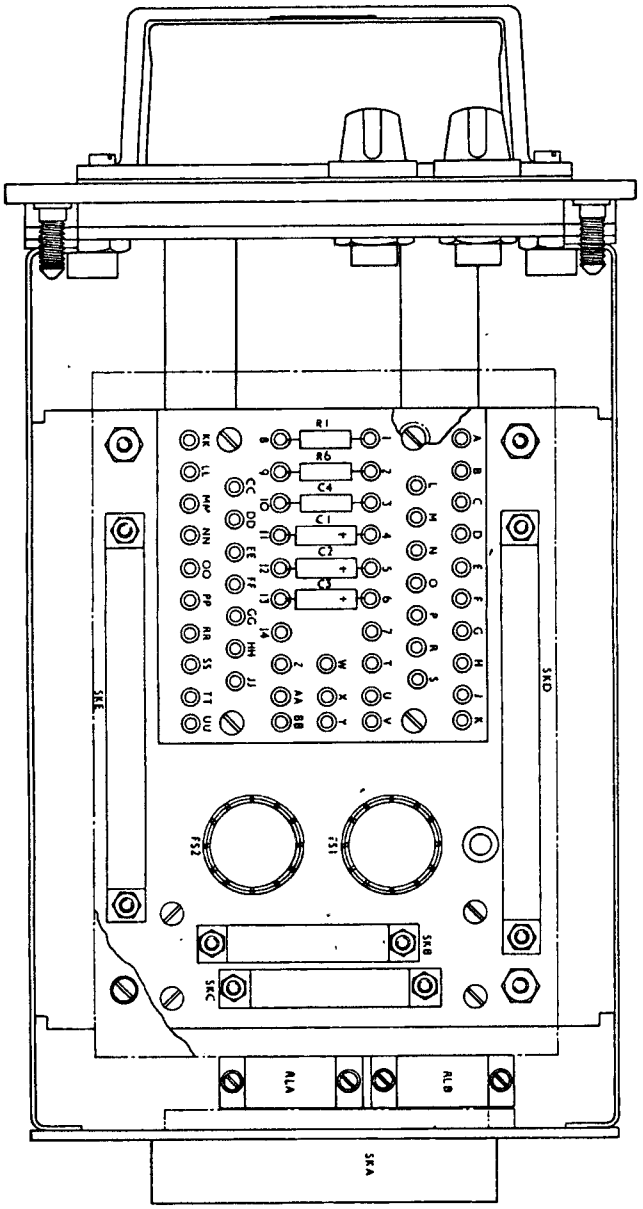
52

RECEIVER/TRANSMITTER
COMPONENT LAYOUT

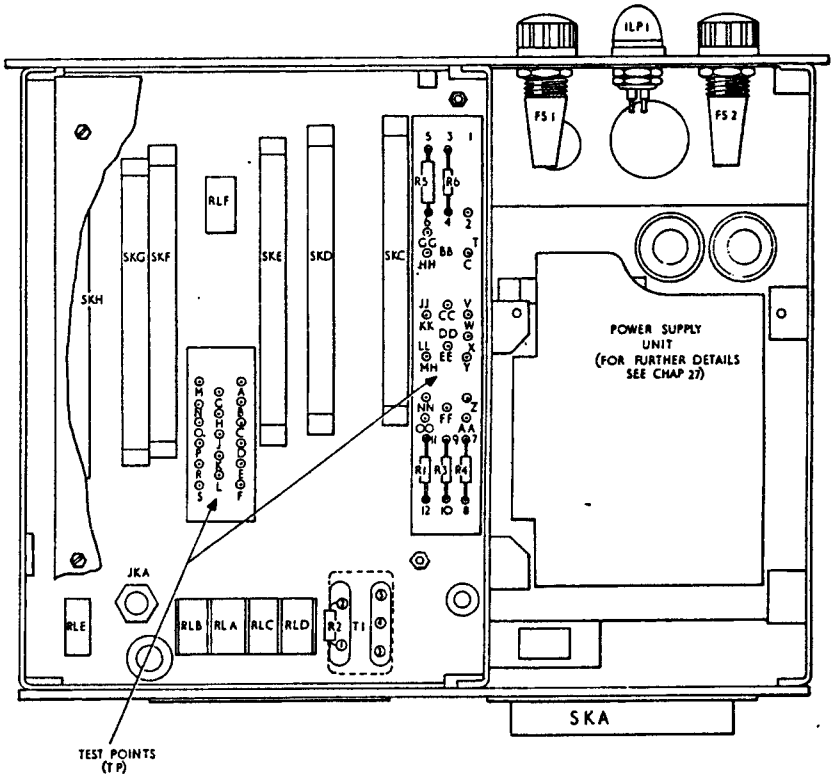

EXT TRIGGER
OSC
PULSE SHAPER
DELAY 100μS
PULSE SHAPER
GATE
OSC 48VHz
ATT
TD Tx
FT/FMS. SW
START/RESET
DISPLAY BLANKING
STOP
MIN DEPTH AMPLIFIER
INITIAL SUPPRESSION SYSTEM
GATE
PULSE SHAPER
TIMER 20mS
AMP GATE & TIMER
CLOCK PULSE GENERATOR
D.R.U.
D.R.U.
TD Rx
PRE-AMP
ATT
GATE
CH/DISC CIRCUIT
A.G.C.
A.G.C.
AMP ECHO SOUNDING
G.S.D.R.

778 BRIDGE UNIT :- DIGITAL READOUT UNIT



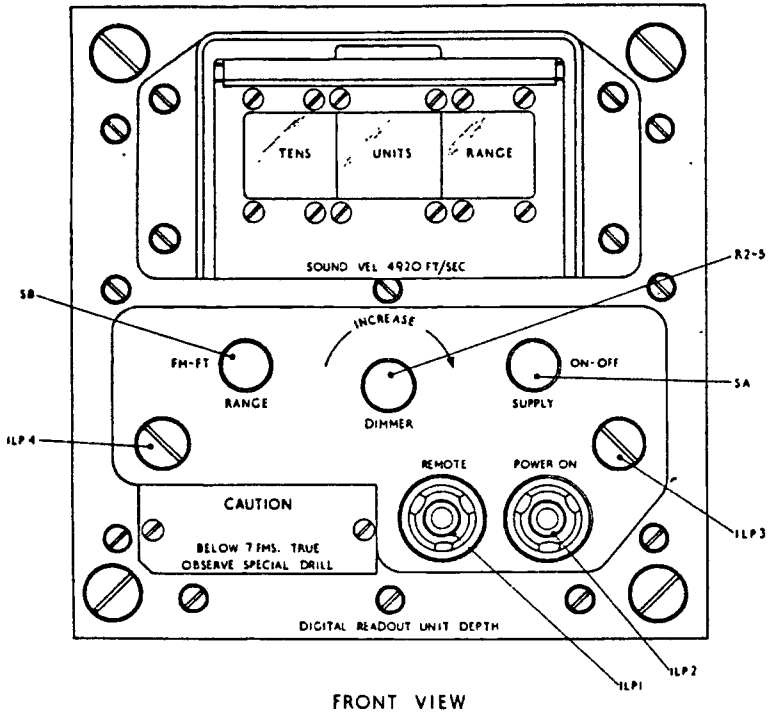


DIGITAL READOUT UNIT, DEPTH
UNDERSIDE VIEW

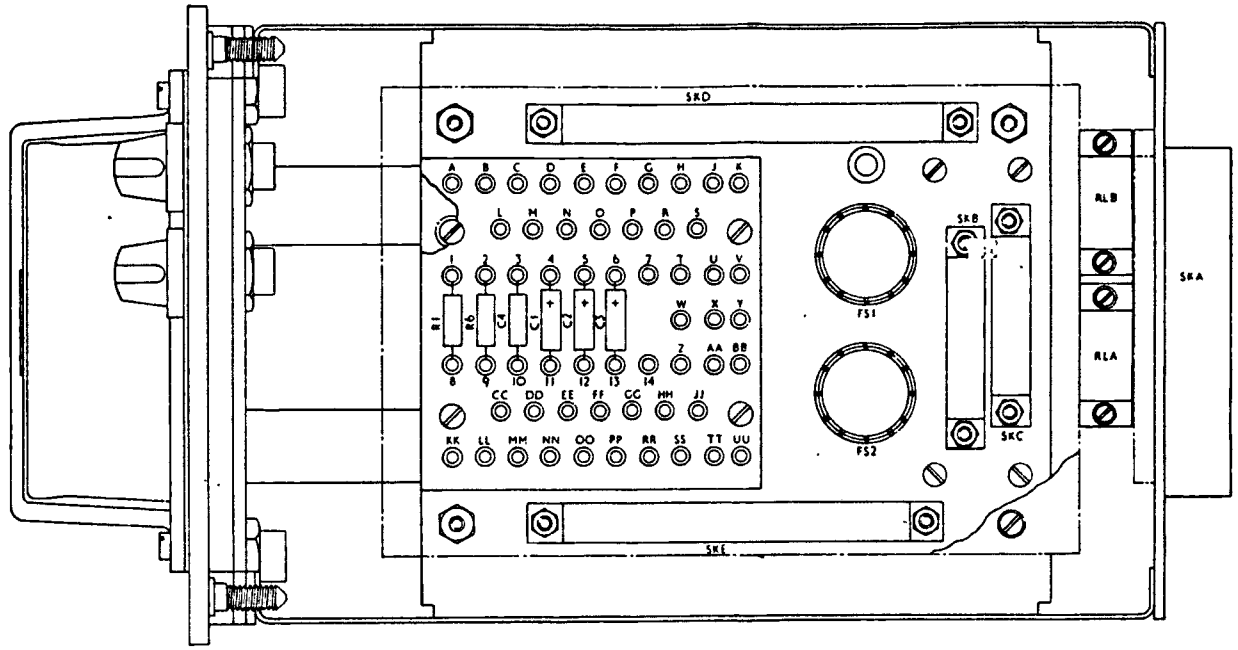


RECEIVER TRANSMITTER
UNDERSIDE VIEW

BRIDGE UNIT
COMPONENT LAYOUT



FRONT VIEW



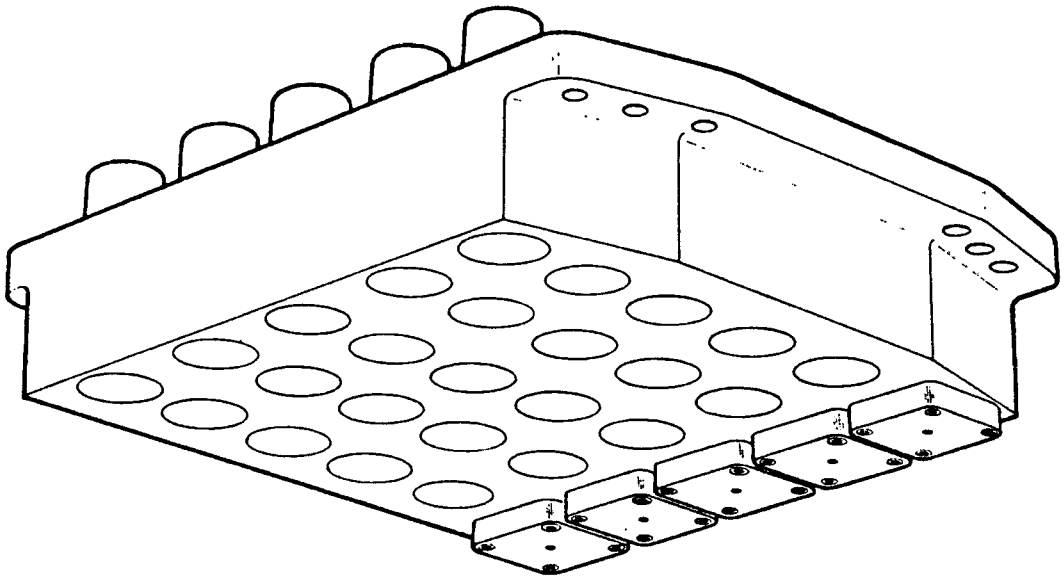
UNDERSIDE VIEW

NOTE-

THE FOLLOWING SUB-ASSEMBLIES ARE USED-

SKB	GATE ELECTRONIC COUNTER	(CHAP 24)
SKC	SWITCH UNIT, ERROR LAMPS	(CHAP 26)
SKD, SKE	COUNTER ELECTRONIC DIGITAL	(CHAP 25)

DIGITAL READOUT UNIT
COMPONENT LAYOUT



DEEP TRANSDUCER

SONAR TYPE 778 TRANSDUCERS

This is a new Echo-Sounder being introduced into the Navy, and it conbines the capabilities of both 773 and 776, together in one set. Predictably, therefore, it has two transducers one for Deep Work and one for Shallow.

DEEP TRANSDUCER (0633/5845 - 99 - 920 - 3377)

This is a direct replacement of the 773 transducer (0633/520 - 3377). It comprises of a matrix of piezo-electric elements which are housed in an Aluminium-Silicon-Bronze forging. Each element consists of five Barium Titanate rings which are mounted between an Aluminium-Silicon-Bronze head and a countermass. A centre bolt keeps the stack compressed even at the maximum amplitude of vibration.

The transducer is mounted on, and insulated from, brackets inside a free-flood space. Sufficient cable is wound on a drum mounted on top of the transducer so that it may be taken through the bottom of the Submarine and up to the deck for servicing.

TRANSDUCER TESTING

Tested at contacts TSA27 and 28 on the GSDR. Continuity resistance between cores 25 $\pm$ 5 . Insulation resistance between core and earth should be greater than 20 Mn.

TRANSDUCER REMOVAL AND REPLACEMENT

Reference BR 2800(3) Chapt 28 Part 5 Sect 3 (Echo Sounder Type 778 Handbook).

SHALLOW TRANSDUCER (0633/5845 - 99 - 920 - 6881)

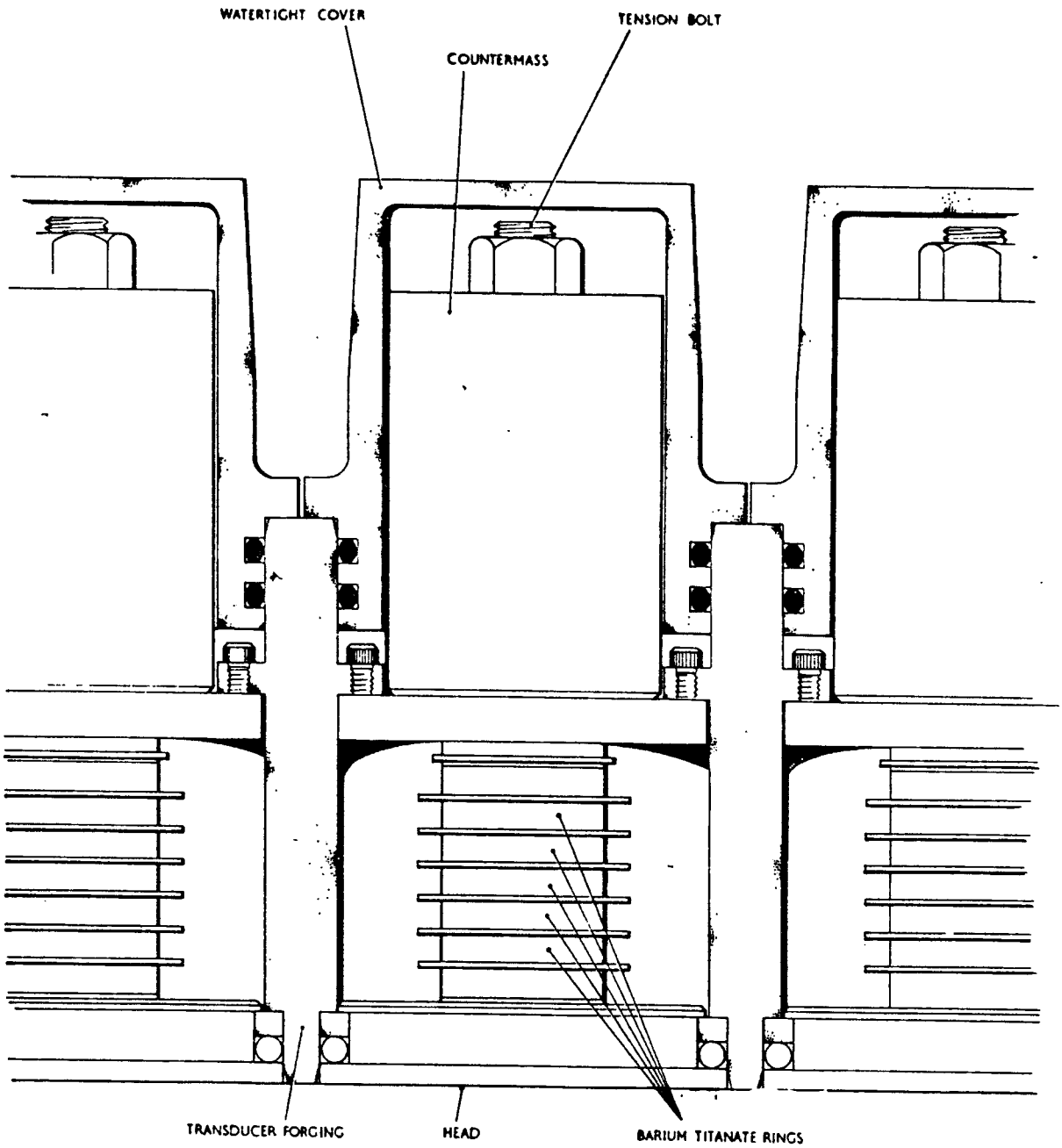
The shallow transducer, which is used in conjunction with the Bridge Unit, comprises a GRP housing containing two Magneto-Striction elements. One is used for transmission and the other for reception. Each element embodies a pair of reflector plates spaced at $\frac{1}{4}$ wave length to cancel out back response. Tuning capacitors are connected in parallel with each element at the tuning box.

The transducer is bolted to a seating ring inside a free flood tank which is vented to a free flood space. Sufficient cable is wound on a drum mounted on the back of the transducer so that it can be brought up to the casing for maintenance.

TRANSDUCER TESTING

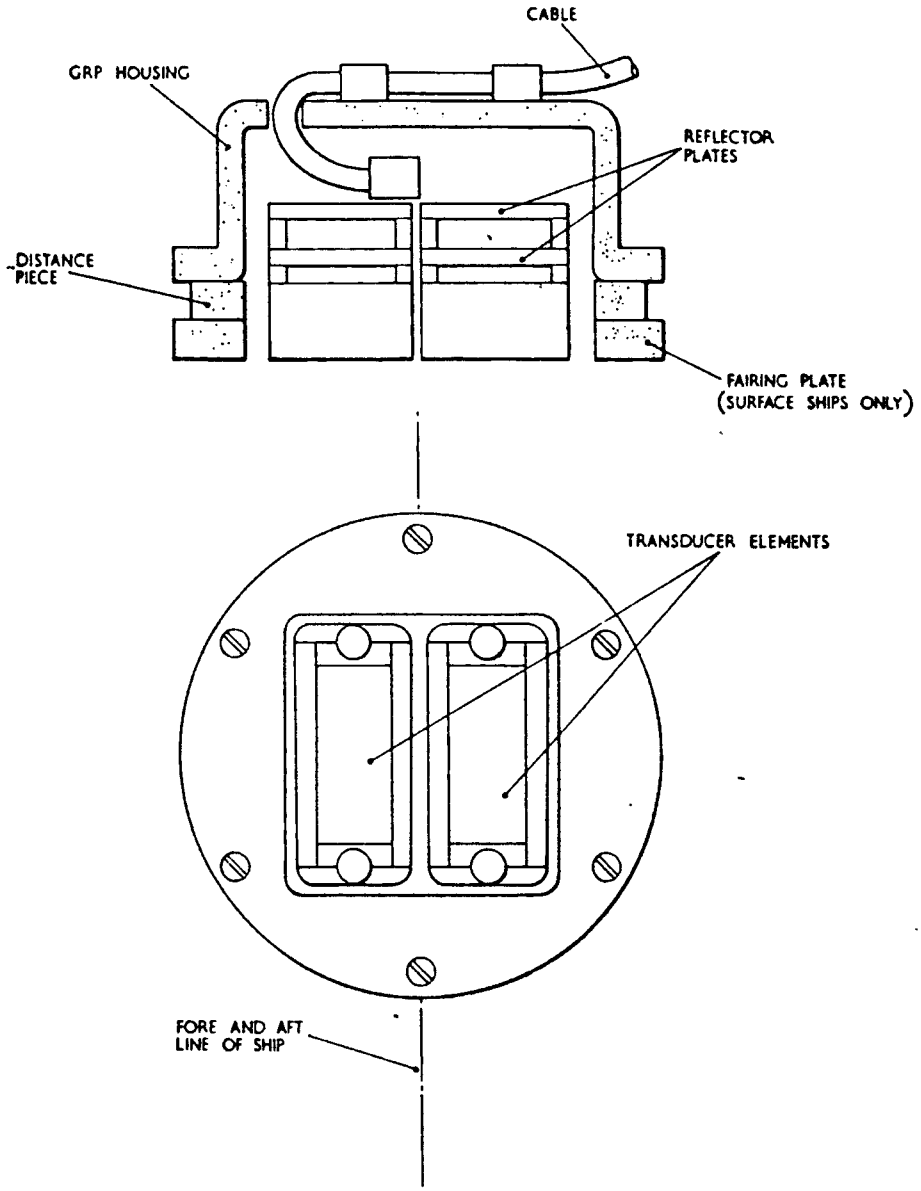
Transmitter: Disconnect Red (L1) and Blue (L2) leads from the tuning box. Using a CT 471 between wires check that the reading is 5n Max. Connected between one wire and earth check that the insulation resistance is not less than 40 Mn.

Receiver: Disconnect the Black or Green (L3) and the Yellow or White (L4) leads from the tuning box. Using a CT 472 between wires check that the reading is 1.5 n Max. Connected between one wire and earth check that the insulation resistance is not less than 40 Mn.



DEEP

TRANSDUCER ELEMENT
DIAGRAMMATIC



GENERAL VIEW OF TRANSDUCER

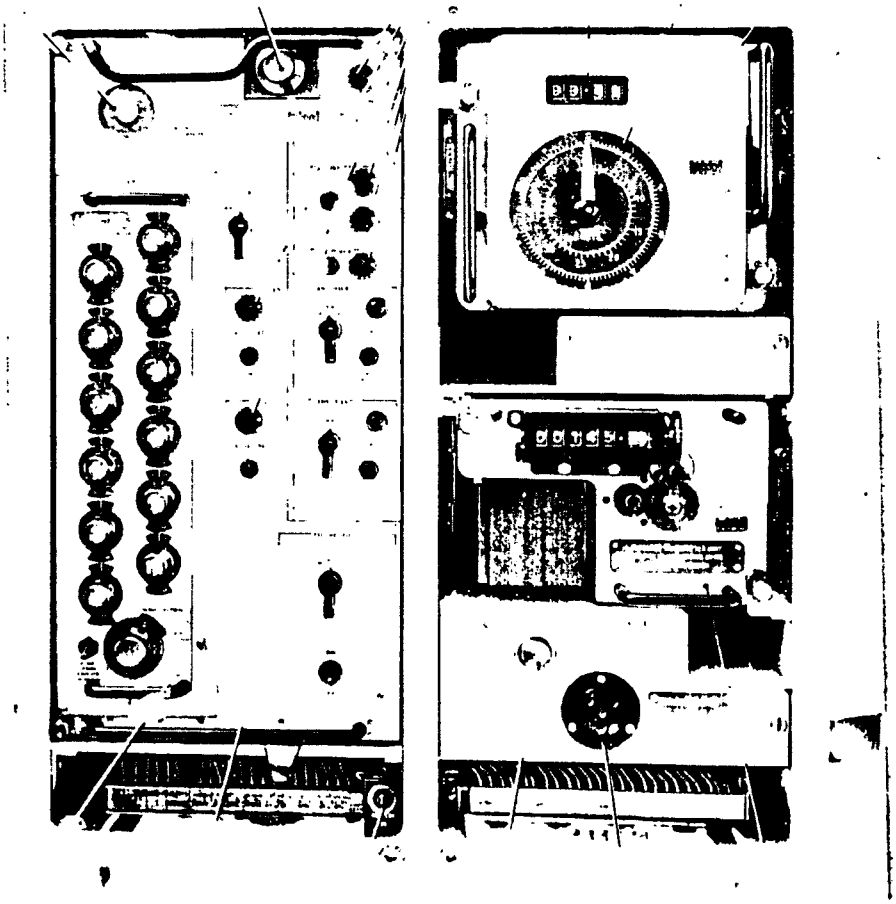
SHALLOW TRANSDUCER

(61)

STANDARD

ELECTRO-MAGNETIC

LOG



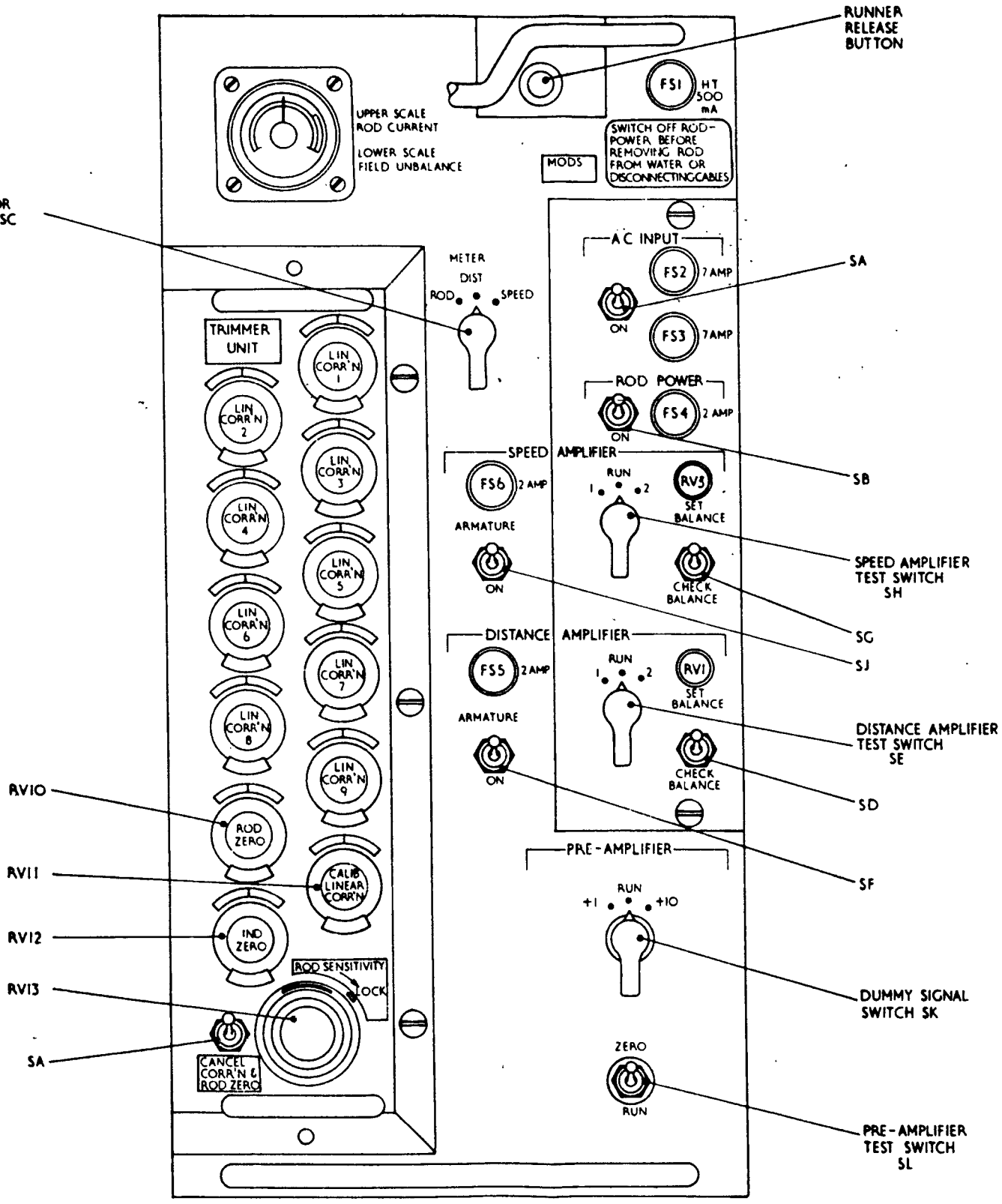
STANDARD E.M. LOG.

QUICK REFERENCE DATA.

POWER REQUIREMENTS.....115v 60Hz.
24v DC.

LOG ACCURACY....., ±0.1Kts.

HANDBOOK..... BR. 268(3b) OPERATION AND MAINTENANCE.



CONTROLS ON FRONT PANEL OF POWER SUPPLY AND AMPLIFIER UNIT

OPERATING INSTRUCTIONS

(1) Switch ON AC supply.
(2) Switch on 24 Volt DC supply for transmission.
(3) Wait 15 minutes (warming up period).
(4) Switch on ROD POWER.
Check ROD CURRENT.
(5) Place meter switch to SPEED.
(6) Check balance of speed amplifier. Make SG adjust
RV3 as necessary. Release SG.
(7) Switch on SPEED ARMATURE.
(8) Operate switch SH and check directional sense of speed servo.
(9) Place meter switch to DISTANCE and check balance of distance amplifier.
Make switch SD. Adjust RV1 as necessary, release SD.
(10) Switch on DISTANCE ARMATURE
(11) Operate switch SE and check directional sense of DISTANCE servo.
(12) Operate DUMMY signal switch SK to PLUS 1 KNOT. The SPEED indicator
dial should read 1 KNOT ± 0.1 KNOT.
(13) Operate DUMMY signal switch to +10 KNOTS. SPEED indicator
dial should read 10 KNOTS ± 0.1 knot.
(14) If satisfactory, place DUMMY signal switch to RUN, switch OFF
Speed and Distance Armatures and Rod Power Supply.

ROUTINE FOR PUTTING LOG INTO OPERATION:

The following supplies are switched ON.
(1) AC (Left on from previous checks)
(2) 24 Volt DC
(3) Rodmeter Power
(4) Speed Armature
(5) Distance Armature

The indicator lamp (230 VOLT NEON) in the Speed and Distance Transmitter Unit will only light when circuits 1,3,4 and 5 have been energised.

NOTES:
Do not switchon Rodmeter coil supply when the Rodmeter is out of the water or when cables are disconnected. If power is supplied to Rodmeter coil when Rod is not in water, overheating of the Rod coil will occur.

If power is required to operate the system without the Rodmeter, a dummy load resistor must be inserted in lieu of the Rod Coil.
CODOCK HAVE THIS DUMMY LOAD

ELECTROMAGNETIC LOG

INTRODUCTION:
The Electromagnetic Log measures the ships speed relative to the water, derives Distance Measurement and provides transmission of speed and distance indication as required, either directly or through Re-transmission units, to Navigational and Weapon Systems. The Log is able to produce an accuracy to within 0.1 Knot throughout the speed range, however the staff requirement accuracy is:

0-3 KNOTS	WITHIN	0.1 KNOT
3-10 KNOTS	WITHIN	0.2 KNOT
OVER 10 KNOTS	WITHIN	2%

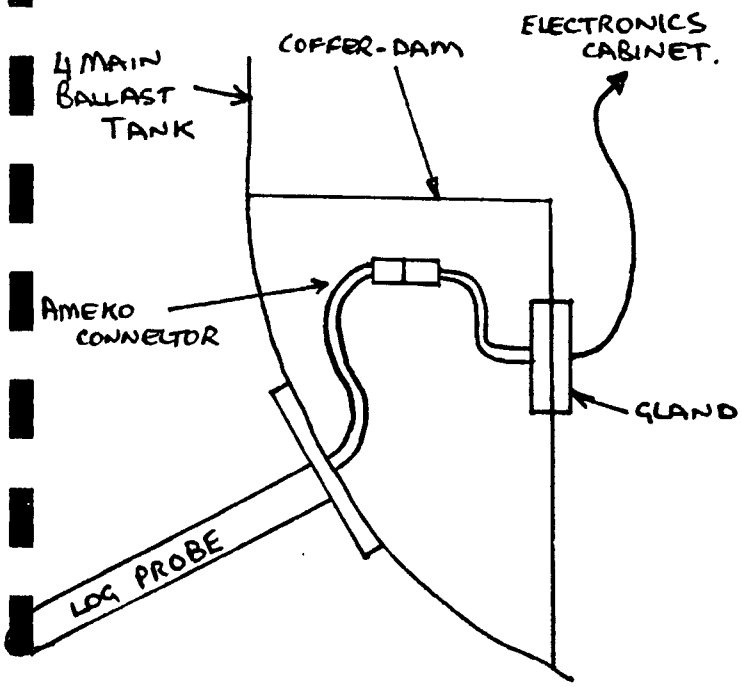
LOG VARIANTS:
(1) Standard.
(2) Transistorized.

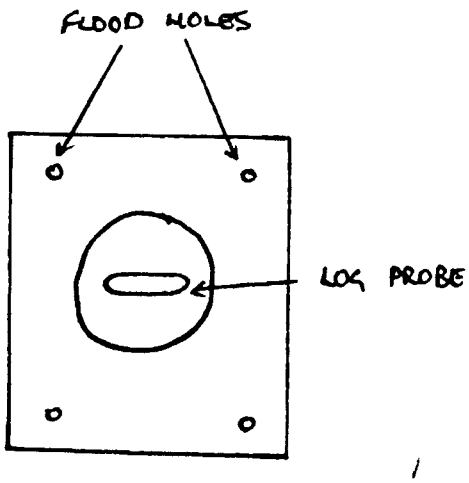
ASSOCIATED UNITS

SPEED AND DISTANCE TRANSMITTER UNIT:
A Bulkhead mounted unit comprising of two main sections. The Left hand side contains the Electronics and the Right hand side containing the Speed and Distance Servo trays.

RODMETER:
The Sensing Head assembly is contained in a Fibre Glass Shell and consists of an AC supplied Iron Cored Coil embedded in Araldite within the shell. Two Bronze Pickups (or buttons), one on either side, flush mounted with the Shell are connected by cables to a Junction Box in the A.M.S.

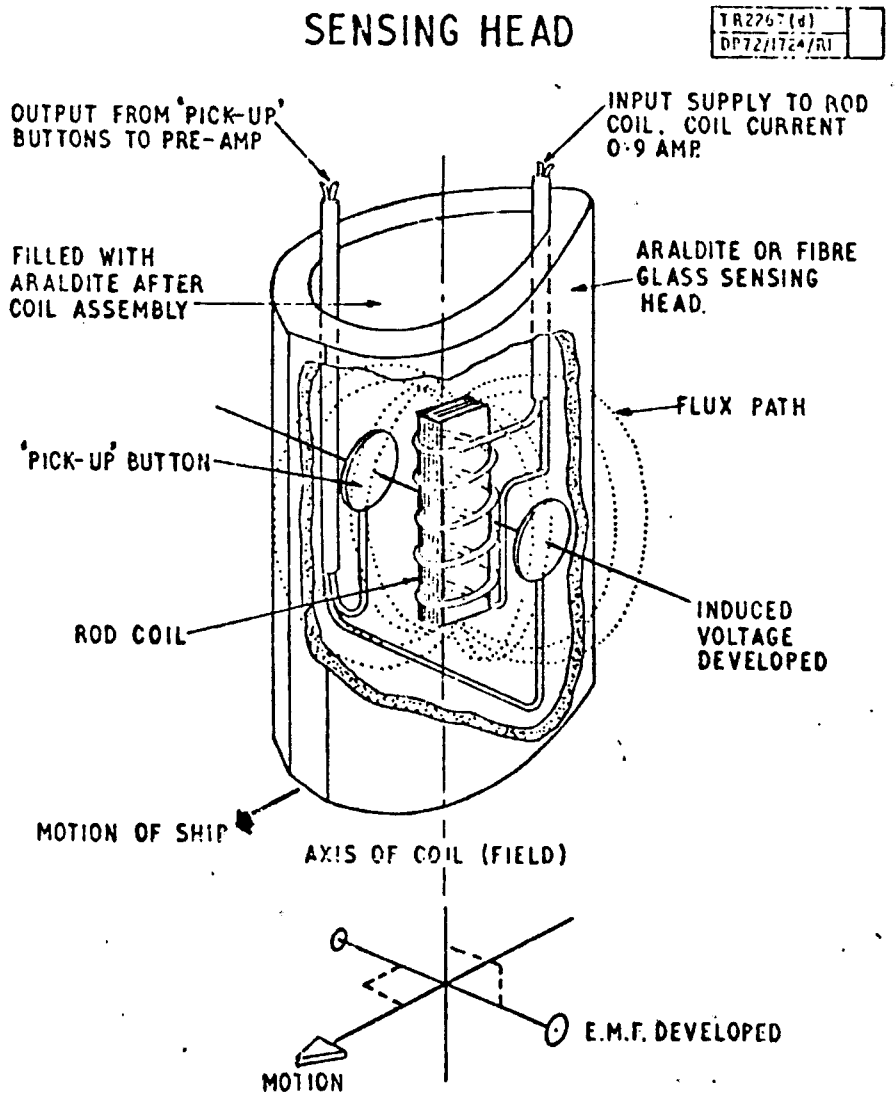
HULL FITTING:
The Rodmeter fitted on Submarines is bolted to the hull of 4 Main Ballast Tank. The electrical cable is passed through into a "COFFER DAM". The Coffer Dam is provided so that when the Rodmeter is to be replaced, AIR will not leak out of the Ballast Tank. (i.e. A Buffer between the probe and the Ballast Tank). The Coffer Dam has 4 Floodholes, (about 50 cm from the Probe), which allows the Pressure to equalize. A specially designed connector (AMEKO) connects the Probe to the Electronics Cabinet.





TRANSMISSIONS:
The number of Ships Speed Transmissions available from the Speed and Distance Transmitter Unit is increased by the use of a Re-transmission Unit. This utilises a single Synchro output from the S.D.T.U. to drive a servo unit connected to a series of gears which drive transmitting elements. Indication of ships Speed is provided by a dial visible through the cover.
Distance information can be relayed by Cam operated Micro Switches operating at rates of 100, 200 and 400 Pulses per Nautical mile.

SUPPLIES:
Normally 115V 60 Hz.
24 V DC.



PRINCIPAL OF OPERATION:
With the Rodmeter Vertical and moving Horizontally through the water at right angles to the Pickup Electrodes. The Magnetic flux produced by the current in the Coil is cut by the sea water acting as a conductor and a small EMF is set up across the electrodes. The EMF developed is proportional to the rate at which Flux cuts into the water, i.e. proportional to the ships velocity through the water.

RODMETER SENSITIVITY:
The outputs of different Rodmeters for the same speed are not necessarily equal. The Signal Voltage produced is of the magnitude 360 - 450 uV per Knot, although considered to have a nominal sensitivity of 400 uV/Knot. It may be necessary to change the sensitivity setting after having completed Calibration Trials to assess Log error or after changing a Rodmeter.

RODMETER ZERO COMPENSATION:
In using an AC supply, a small AC voltage will be developed in the signal circuit due to Transformer action, which will be very nearly in Quadrature (PHASE) to the signal voltage proportional to ship velocity. The small inphase component of this voltage due to transformer action measured in absolutely STILL water conditions must be balanced out otherwise a permanent error would persist over the whole range of speeds. This is achieved by the Rod Zero Potentiometer.

PRODUCTION OF SPEED:
The principal components are Preamplifier, Phase Conscious Rectifier, DC Power Amplifier, Split Field Servo Motor, Reset Potentiometer and Reset Correction Potentiometer.

Preamplifier:
The signal voltage from the Rodmeter is applied to the Primary of the input Transformer, T5, and stepped up approximately twice (X2) in the Secondary. A Resetting signal from the Trimmer Unit is applied to the Secondary in a sense which always tries to reduce the effective output of the Transformer to ZERO. The Algebraic Sum of these two signals is known as the CORRECTION signal and is applied to the first stage of a three stage CASCADE amplifier with gain control effected by varing the Negative Feddback applied over the three stages. The output of the third stage is Directly Coupled to a Cathode Follower which feeds the centre tap of the Phase Conscious Rectifier Transformer.

Phase Conscious Rectifier:
The output of the Preamplifier will have a phase relationship to the reference voltage dependant on Speed increasing or decreasing. The Reference voltage is developed by the Rodmeter Coil Current passing through a Resistor of value 1 Ohm. The Primary of the P.C.R. Transformer is connected across this resistor giving a Secondary voltage of 30V-0-30V. For steady conditions, say for one half cycle employing MR2 and MR4, the current flow in the lower half of the Transformer is counterbalanced by that in the upper half, thus the effective potential across capacitor "A" is nil, point "X" is at the same potential as -HT. The second half cycle will show that point "Y" is held at the same -ve potential for the same reason, using rectifiers MR1 and MR3 and capacitor "B". RV1 is included to balance out the effect of any component tolerance. The effect of a signal being passed to the Centre Tap of the Transformer is (dependant on PHASE) equivalent to shifting the Centre Tap away from the centre position, thus increasing the EMF at one end and decreasing it at the other. The current flow in opposite directions for each half cycle will now be unbalanced and a potential difference will appear across the Capacitors causing one to go Positive and the other Negative in respect to HT -ve, thus giving a potential difference between points "X" and "Y".

DC Amplifier:
The DC signal from the PCR is first modified by a Velocity Feedback signal from a Tacho Generator, then fed to a voltage amplifying stage. The Amplified output from this stage controls a pair of BEAM TETRODES with a common Cathode coupling and Anodes fed through opposing halves of the Speed Servo Motor Field winding. Hence, the motor Torque is proportional to the difference between the Anode currents.

DC Amplifier Continued:
Shaft rotation drives the Resetting Potentiometer fed with the Reference Voltage from the Trimmer Unit, thus a voltage proportional to speed is picked off and fed back, via the Trimmer Unit , to the Preamplifier Input Transformer to balance out the signal from the Rodmeter and hold the system at the indicated speed.

Trimmer Unit:
The Voltage Induced at the Sensing Head by the ships motion is in general proportion to the Rodmeter speed with respect to the water. But, the flow characteristics of the water past the Rodmeter (whether Smooth or Turbulant) and the Eddies created by the Hull shape all combine to distort the output from a TRUE LINEAR output. It follows that if a linear Resetting signal, developed by Shaft rotation for Speed, is used then a balanced condition will be reached when indicating an incorrect speed. To overcome this effect of the slight NONLINEAR output from the Rodmeter, the Resetting Potentiometer voltage must be allowed to apply a voltage proportional to the TRUE SPEED. This is achieved in the TRIMMER UNIT by employing a further network across the voltage developed to feed the Resetting Potentiometer. This Network consists of nine [9] Potentiometers connected across the Reset Correction Potentiometer. The outputs of the Wipers of these Linear Correction Potentiometers are taken to nine Taps on the Resetting Potentiometer, whose shaft is also rotated proportional to Speed, thus the voltage picked off at any instance will be related to the position of its Wiper Arm in respect to any two [2] Taps. The ends of the Reset Potentiometer are connected together and to the Common Rail so that the correction at ZERO and 40 KNOTS is always Zero. The output of the Correction Potentiometer is returned to the Trimmer Unit where it is mixed with the Reset voltage from the Resetting Potentiometer, so that the resultant voltage is made exactly proportional to the output of the Rodmeter for that particular Speed. The Indicator system covers a range of 0 - 40 KNOTS, but a complete shaft revolution of the Resetting Potentiometer is equivalent to a 50 KNOT range. The DEAD space is to allow for INITIAL ALIGNMENT considerations. It follows that at ZERO indication, the Resetting Potentiometer would hold a voltage that would drive the system below ZERO, unless balanced out. A signal of appropriate Phase and Magnitude is picked of by the Indicator Zero Potentiometer and mixed with the Reset and Resetting Correction signals in order to hold the system at indicated zero. The outputs of different Rodmeters at the same speed are not necessarily equal. This condition is overcome by feeding the output of the mixed Reset, and Indicator Zero signal to the Wiper of the Rodmeter Sensitivity Potentiometer, to permit variation of the Attenuation Ratio of these signals.

CALIBRATION TRIALS:
A series of runs over the measured distance must be made at speeds of 4, 8, 12, 16 and 20 Knots and at 4 Knot intervals to Maximum Speed. During the Calibration runs the ships actual speed over a measured distance is compared with the Indicated Distance from the LOG during the same period. The difference between the two readings is called the Numerical Log Speed Error and is plotted graphically.
The error result expressed as a percentage of true speed indicates the degree and sign of the correction to be applied. The dial markings on the Linearity Correction Potentiometers correspond to the effect the setting would have on indication. All calibration runs are completed before any corrections are applied, on applying corrections, check calibration runs are undertaken. It is possible that results will show errors indicating a basic percentage error. In this case, Rod Sensitivity Potentiometer setting would be revised and linearity corrections applied to the Linear Correction Potentiometers.

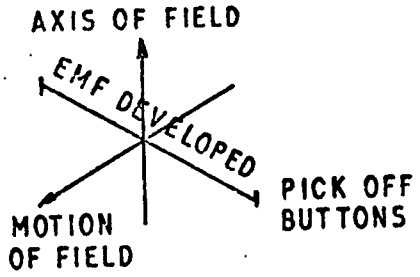
THE CALIBRATOR:
This is a built in facility on the standard system and in the Transistorised system it is a separate portable unit, however both units fulfil the same function. Its main purpose is to initially set up the electrical and scale zero postions of the nine Linearity Correction Potentiometers, which is essential prior to the ship carrying out calibration trials over the measured mile. Subsequently, and after the linearity corrections have been applied, the calibrator enables ships staff to check the accuracy of these settings.

TR2267(a)
DP72/1722/P1

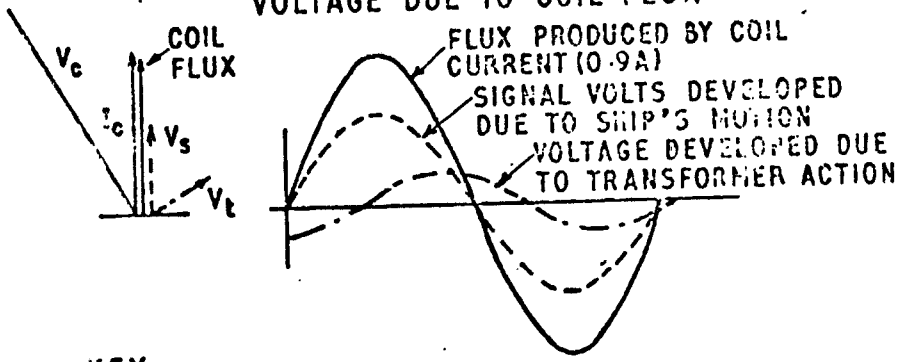
ELECTRO – MAGNETIC LOG

DEVELOPMENT OF ROD SIGNAL AND ROD ZERO COMPENSATION

PRINCIPLE EMPLOYED (FARADAYS' LAW)



THEORETICAL DEVELOPMENT OF VOLTAGE DUE TO COIL FLUX



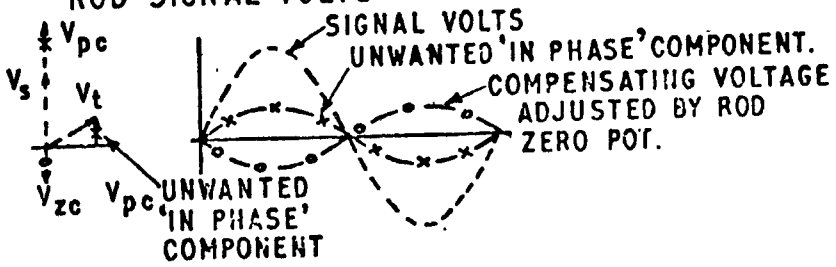
KEY

V_c – COIL VOLTS
V_s – SIGNAL VOLTS
V_t – VOLTAGE DUE TO TRANSFORMER ACTION
V_{pc} – 'IN PHASE' COMPONENT DUE TO TRANSFORMER ACTION
V_{zc} – COMPENSATING VOLTAGE REQUIRED

NOTE:–

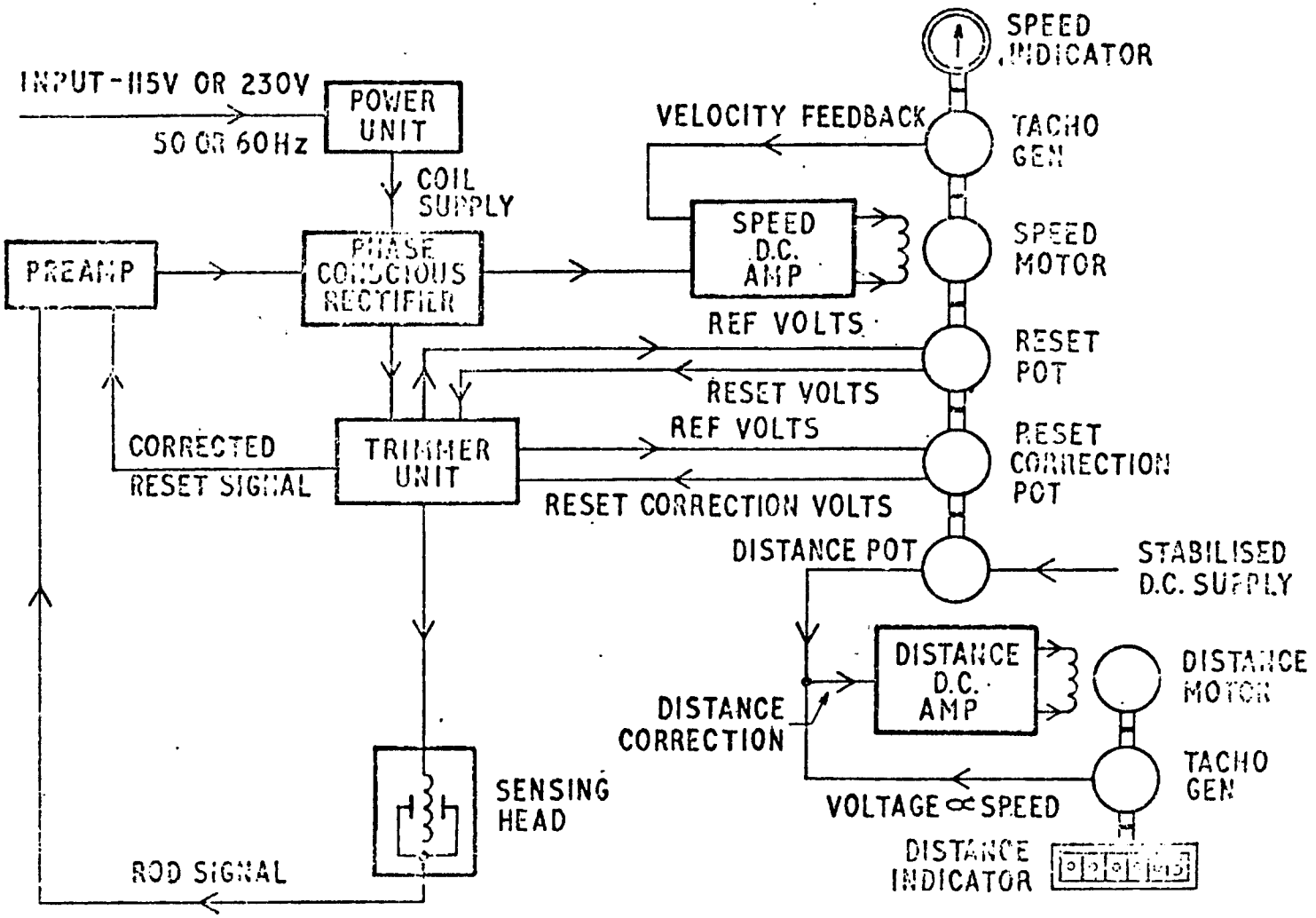
1. SUPPLY TO COIL IS 115V 60 Hz – CURRENT IN COIL IS ADJUSTED TO 0·9 AMPS.
2. THE UNWANTED 'IN PHASE' COMPONENT IS MEASURED & COMPENSATED IN ABSOLUTE STILL WATER.

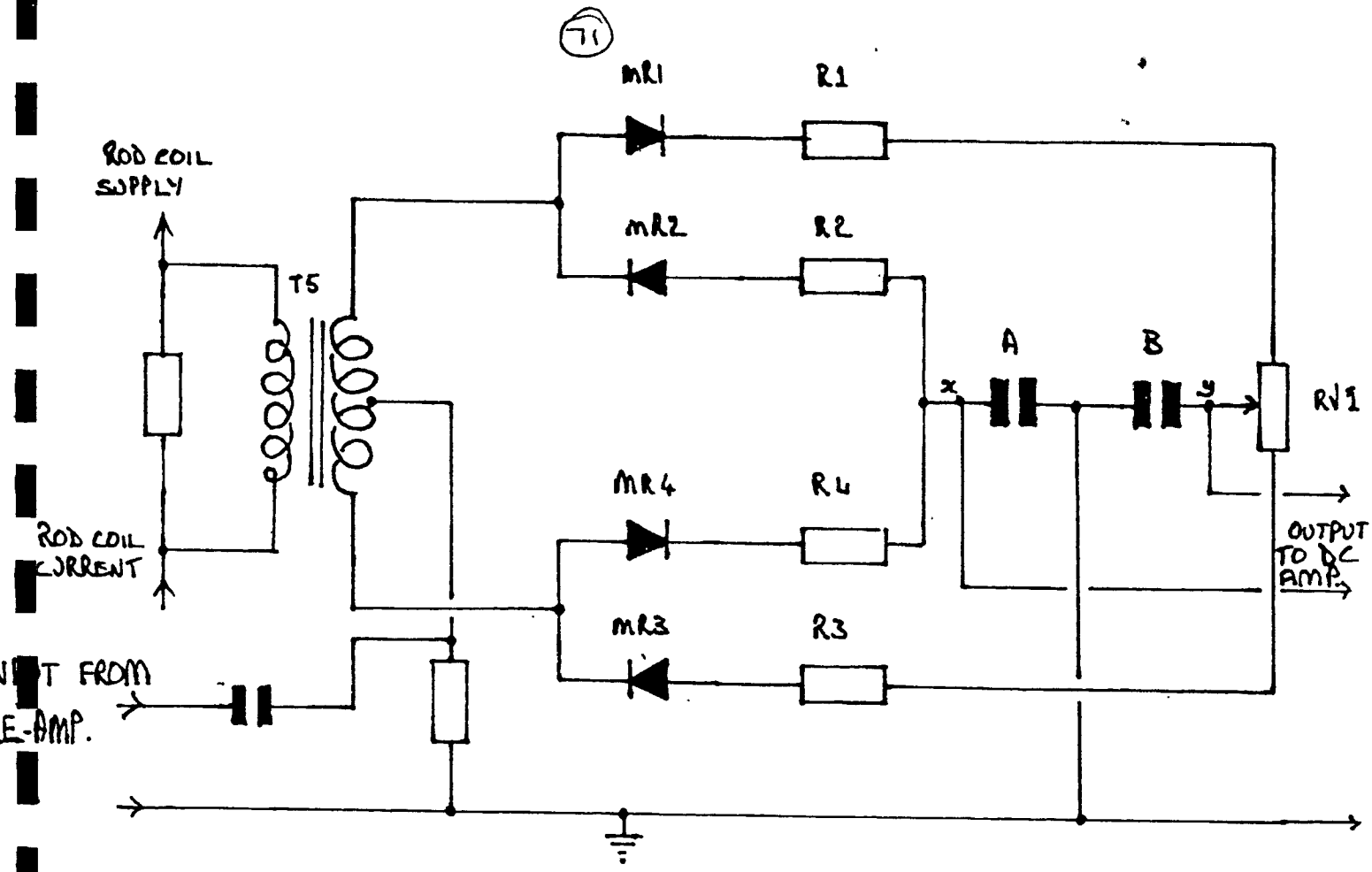
ACTUAL DEVELOPMENT OF CORRECTED ROD SIGNAL VOLTS



ELECTRO - MAGNETIC LOG
SCHEMATIC ARRANGEMENT

TR.1895
D.R.74/63/13



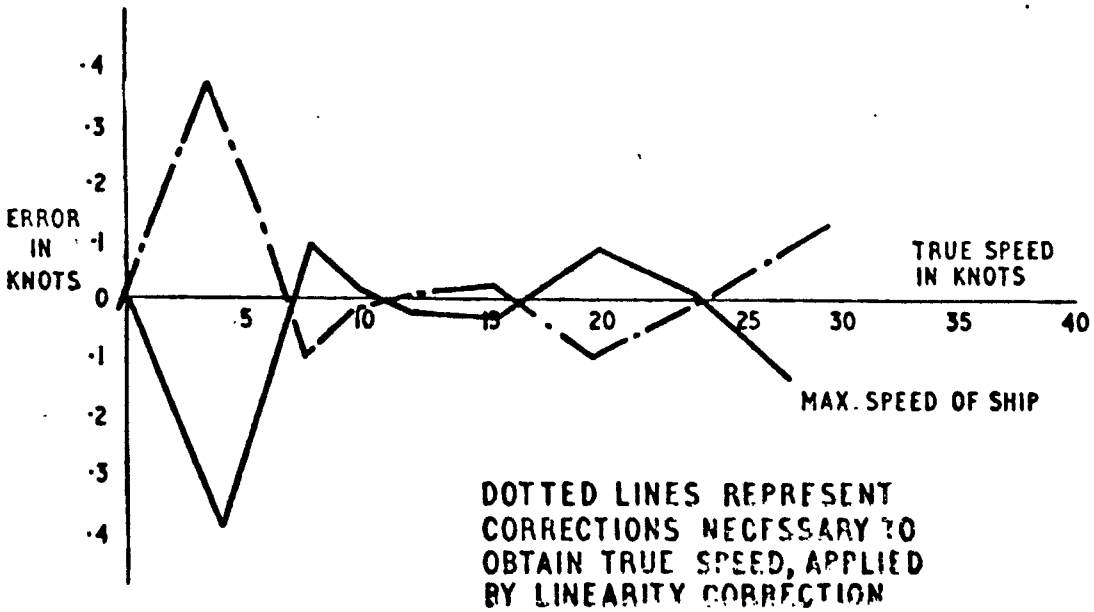


PHASE CONSCIOUS RECTIFIER

TR2267 (c)
DP72/1724/R1

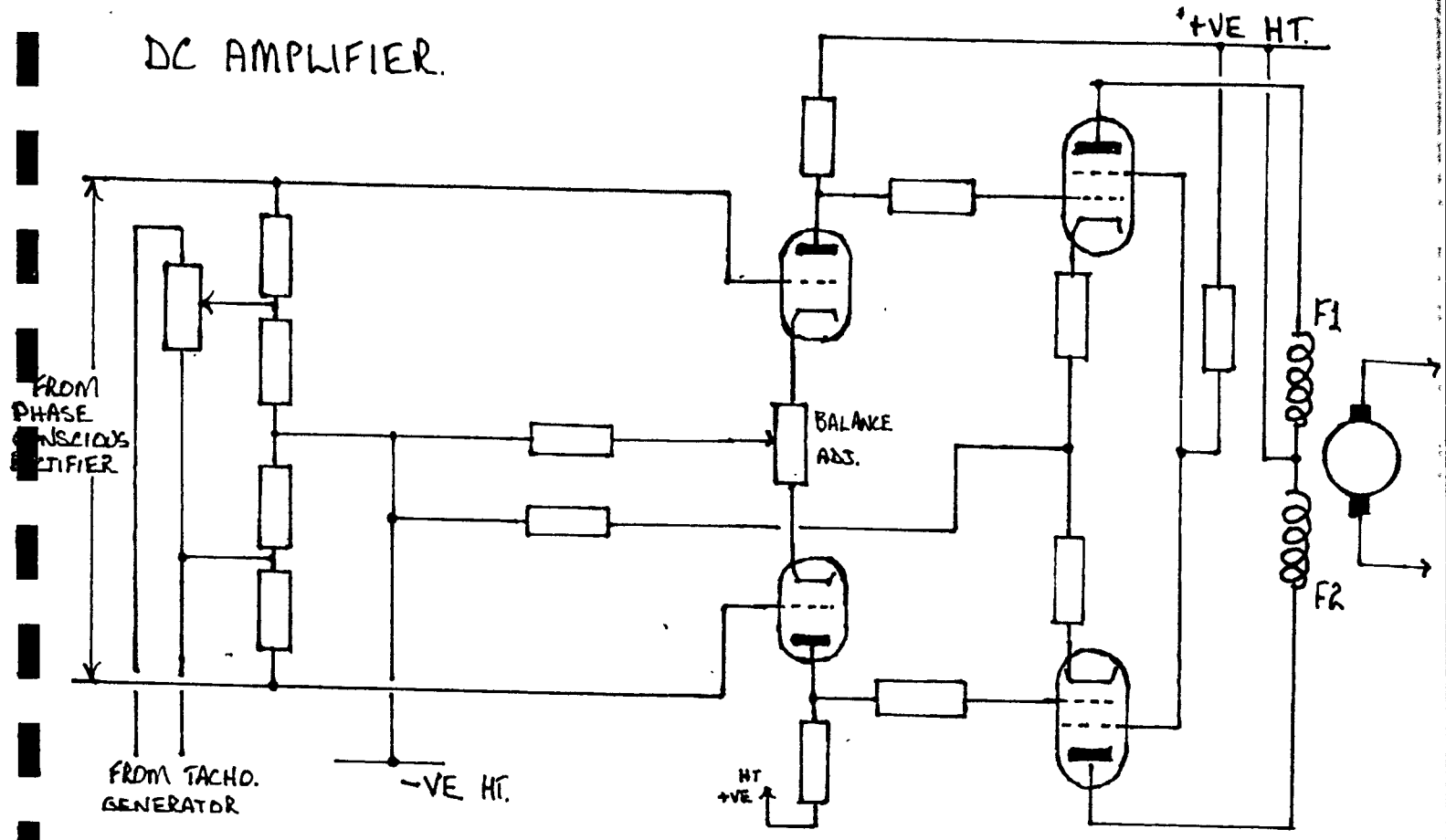
ERROR GRAPH (TYPICAL)

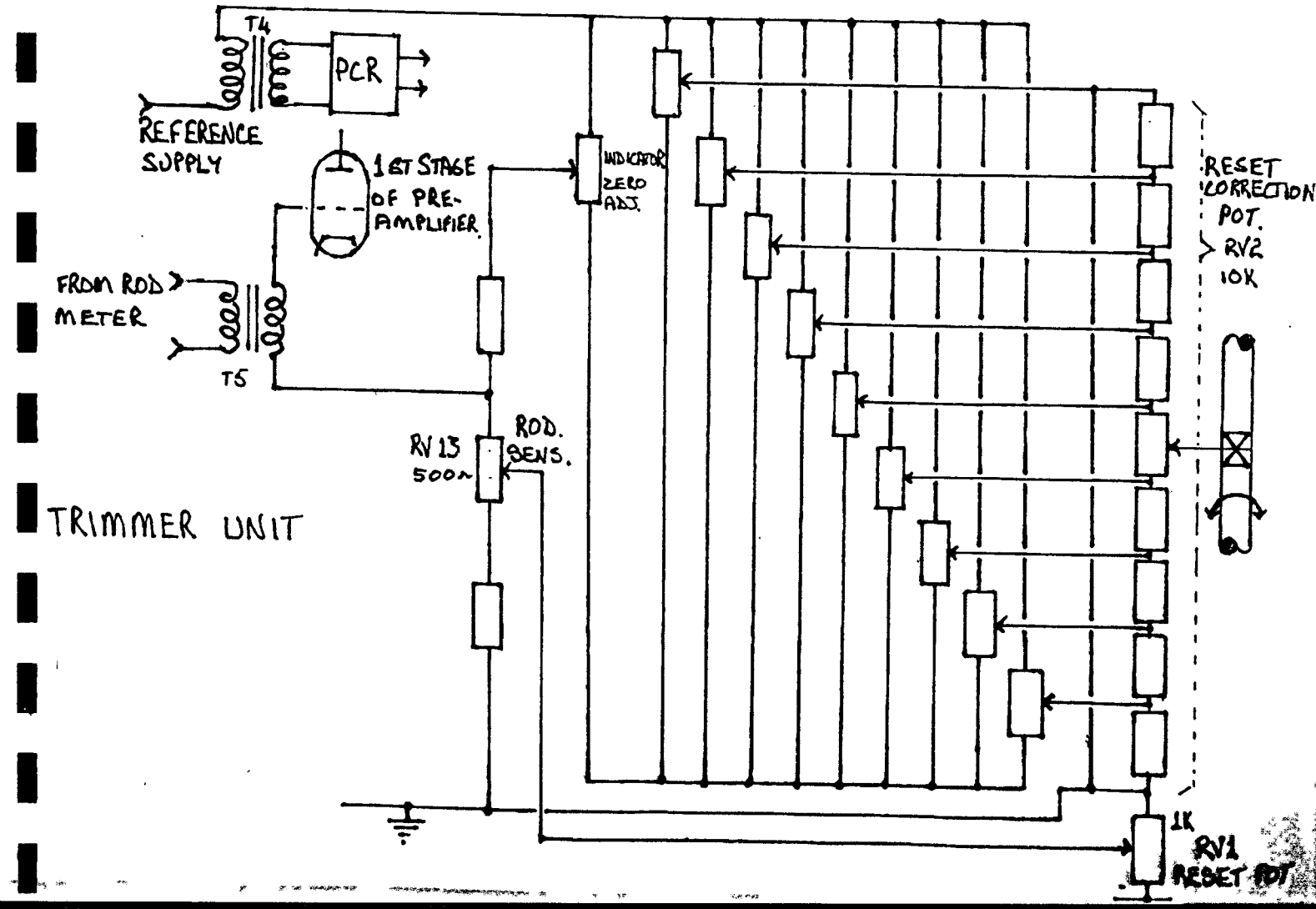
OBTAINED DURING RUNS OVER MEASURED MILE



DOTTED LINES REPRESENT CORRECTIONS NECESSARY TO OBTAIN TRUE SPEED, APPLIED BY LINEARITY CORRECTION POTENTIOMETERS.

DC AMPLIFIER.

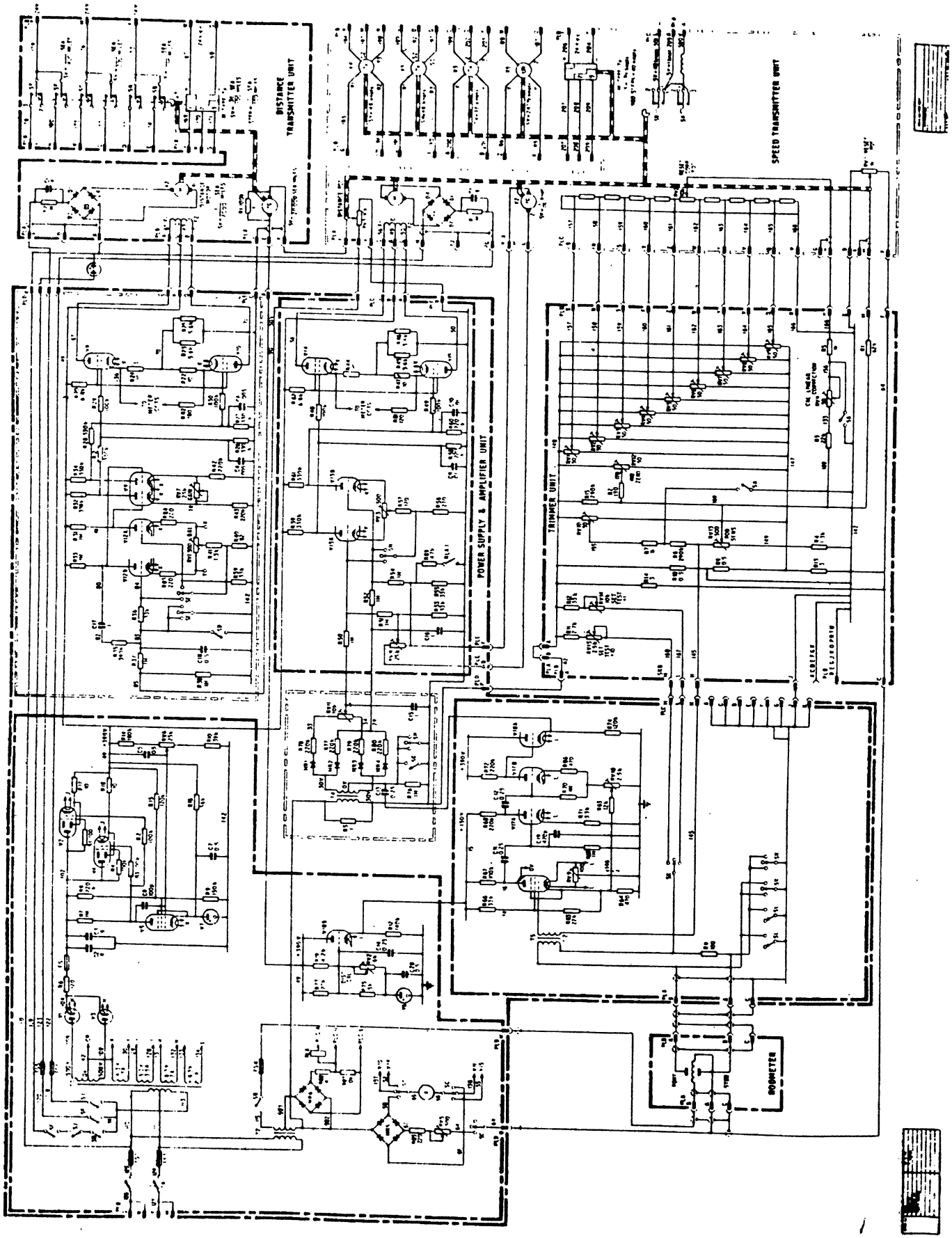




TRIMMER UNIT

Cat. No. 2331
DF 60/5560

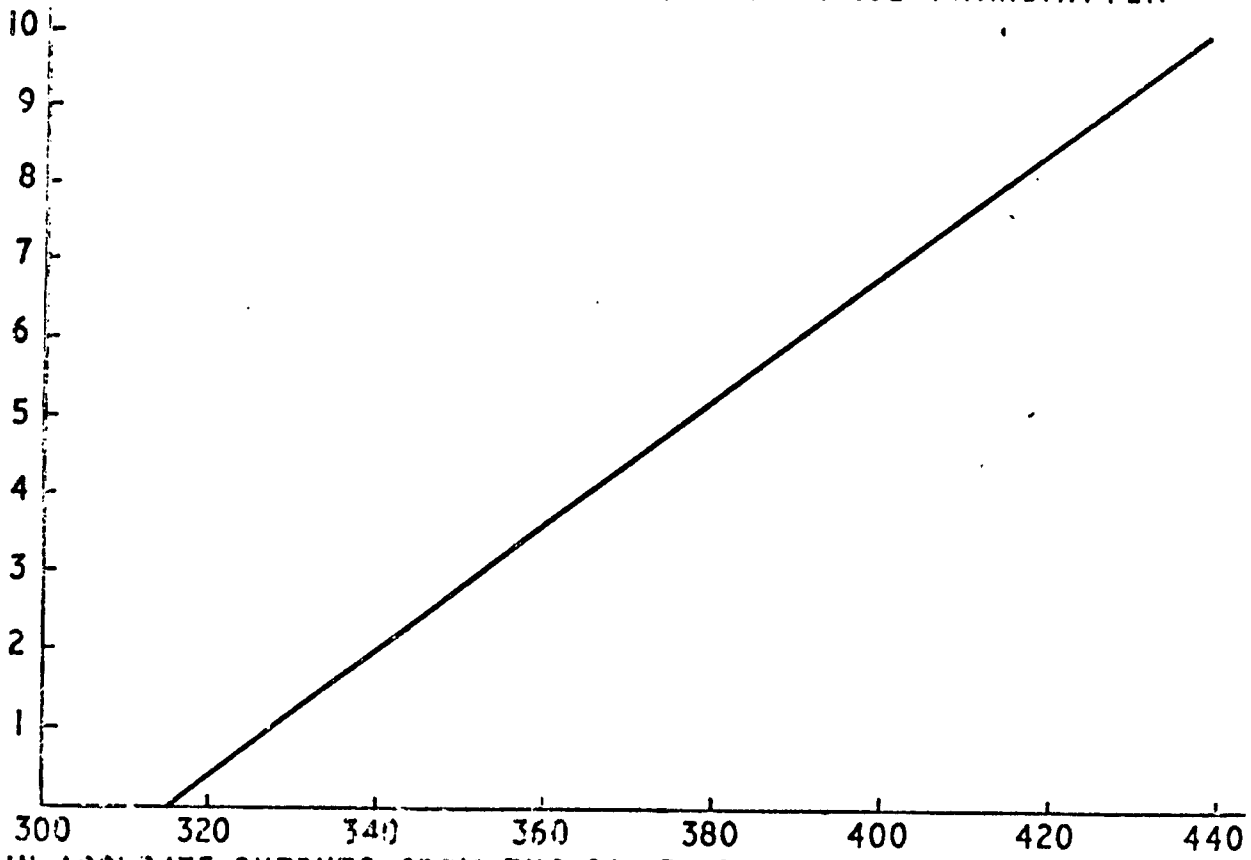
ELECTRO-MAGNETIC LOG — CIRCUIT DIAGRAM



ELECTRO–MAGNETIC LOG
ROD SENSITIVITY CALIBRATION GRAPH
(SUPPLIED WITH LOG EQUIPMENT)

TR2267(E)
DP72/1724/R

ROD SENS. DIAL SET SUPPLIED WITH SPEED AND DISTANCE TRANSMITTER

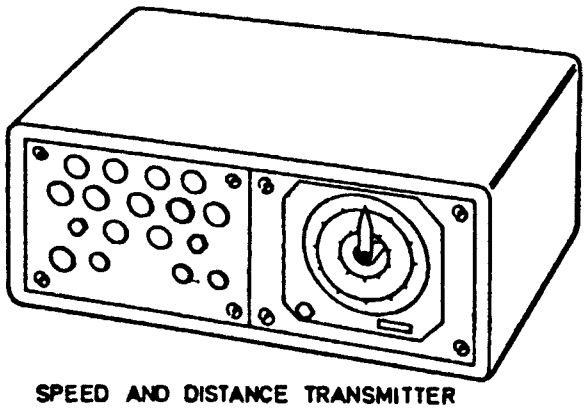


TO OBTAIN ACCURATE OUTPUTS FROM THE CALIBRATOR WHEN SIMULATING SPEEDS IN STEPS OF 4 KNOTS, THE CALIBRATOR DIAL (RV1) SHOULD BE INITIALLY SET TO 2/65 AND THE ROD SENSITIVITY DIAL (RV13) TO 7/00.

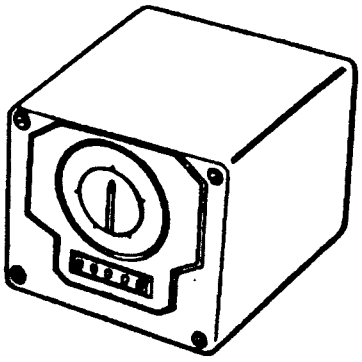
WHEN CALIBRATING DISTANCE, THE DISTANCE CALIBRATION DIAL (RV2) SHOULD BE INITIALLY SET TO 6/67 AND THE CALIBRATE LINEAR CORRECTION DIAL SETTING (RV11) SET TO 2·00.

(75)

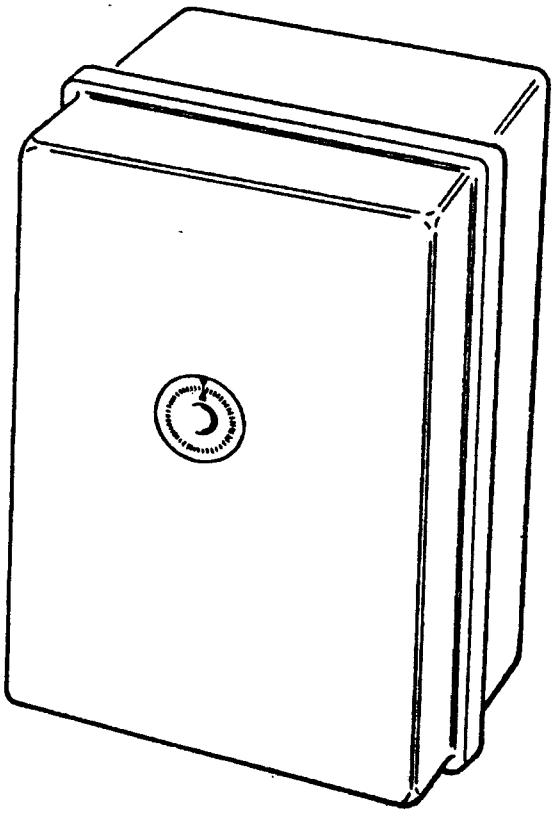
TRANSISTORISED ELECTRO-MAGNETIC LOG



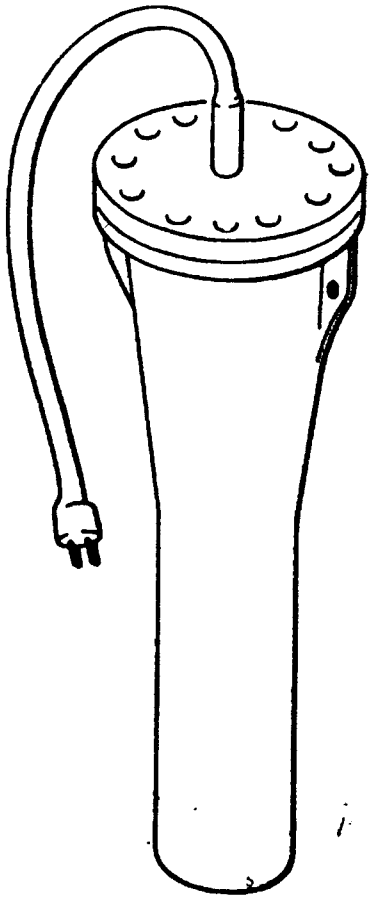
SPEED AND DISTANCE TRANSMITTER



VCS TYPE 84 UNIT



RETRANSMISSION UNIT



FIXED PROBE

TRANSISTORISED E.M. LOG.

QUICK REFERENCE DATA.

POWER REQUIREMENTS.....115v 60Hz.
24v DC.

LOG ACCURACY..... ± 0.1 KNOTS.

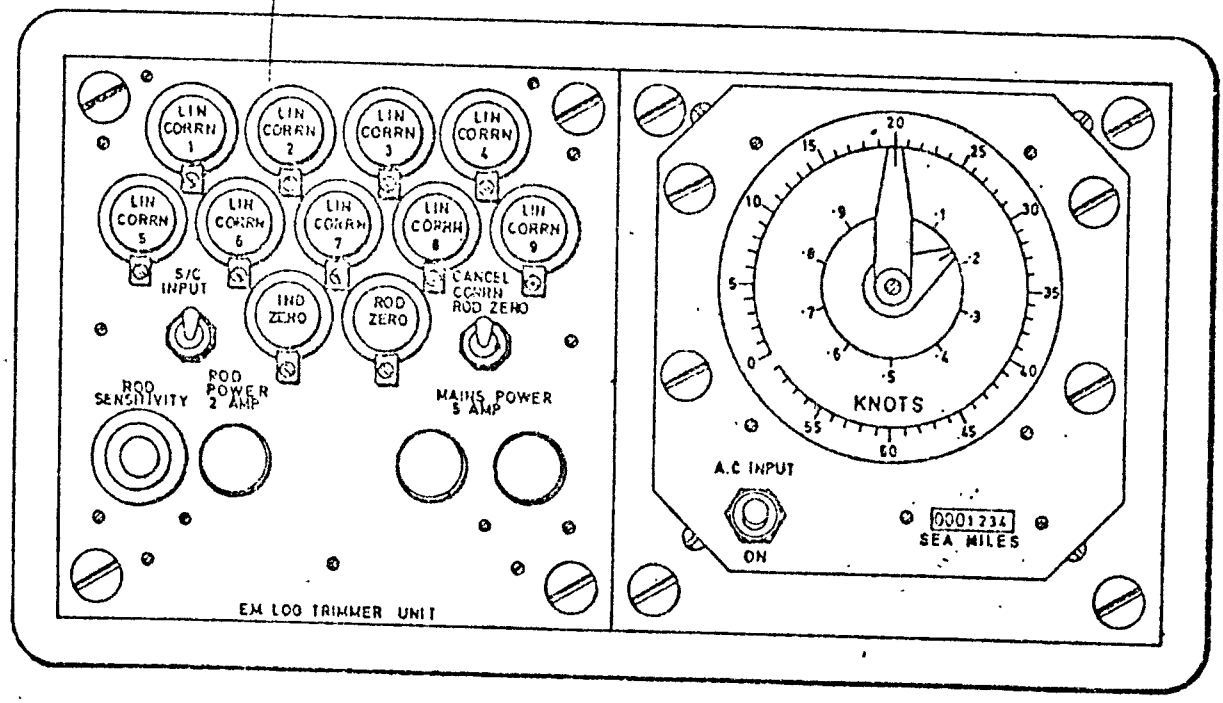
HANDBOOK.....BR. 6503 OPERATION AND MAINTENANCE.

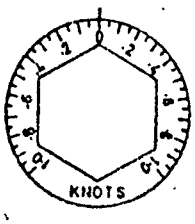
TRANSISTORISED ELECTRO-MAGNETIC LOG

TECHNICAL DESCRIPTION

INTRODUCTION

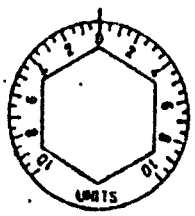
1. The speed and distance transmitter unit comprises a console, into which is plugged an indicator unit and a trimmer unit, and a calibrator which is stowed separately. The equipment housed in the console incorporates two servo systems, a positional servo and a velodyne servo. The former provides a synchro transmission of speed and the latter, controlled by the positional servo, produces a series of dc pulses representing distance travelled. Visual indication of speed is provided by a clock type dial calibrated in knots; a numerical register displays distance travelled in sea miles. The calibrator is used when injection of a fixed known speed signal is required.





DIAL ENGRAVING FOR 'LIN CORRN' 1 TO 9

DIAL ENGRAVING FOR 'ROD ZERO' AND 'IND ZERO'



SPEED AND DISTANCE TRANSMITTER UNIT - FRONT PANEL

FUNCTIONAL DESCRIPTION

2. The input to the positional speed servo is pre-amplified and fed via an ac amplifier to a phase-sensitive detector (PSD). The PSD compares the phase of the amplified input signal with that of a phase reference voltage to produce a dc output which is amplified to drive the motor M1 on the speed shaft. Tacho generator TG1 provides velocity feedback.

3. Synchro transmissions proportional to speed are provided by two externally excited control transmitters geared to the speed shaft.

4. A reset potentiometer RV16 provides an anti-phase feedback proportional to shaft position to complete the servo loop. Potentiometer RV15 is used to correct any non-linearity in probe signal due to inconsistency of water flow past the probe.

5. The input to the velodyne distance servo is a voltage proportional to speed obtained from the distance potentiometer RV17 coupled to the speed shaft. Tacho generator TG2 provides velocity feedback. Six cams driven via gearing from the distance shaft, each operate a micro switch which interrupts an external 24V dc supply to provide three different pulsed outputs representing distance.

6. To provide local indication of speed a mechanical output from the speed shaft drives a clock type dial giving readings in knots and tenths of a knot to a maximum of 60 knots. A drive from the distance shaft is connected via gearing to a cyclometer type display giving readings in sea miles and tenths of a sea mile to a maximum of 99,999.99 sea miles.

CIRCUIT DESCRIPTION

Power Supplies

7. The 115V 60Hz is applied to SKC pins 22 and 23 of the electronic unit and, via FS2 and FS3 to the Mains On/Off switch in the indicator unit. Pin 1 is connected to an external earth. A supply is then taken from the indicator unit, via SKC pins 18 and 19, to transformer T3 in the electronic unit. The line side is also taken direct to two rectifying circuits comprising C16, C17 and D13 to D20 inclusive. The neutral to these circuits is routed via the main input transformer. Both circuits supply power to the servo motor armatures.

8. Transformer T3 has three secondary windings, two of which are centre tapped, rectified by diodes D1, D2, D3 and D4, and smoothed by capacitors C8 and C9 to provide a +30V dc and -30V dc supply with respect to the OV rail. A supply for the indicator lamps is teken from one secondary before rectification.

9. The unstabilised 30V +ve and -ve supplies are fed to IC1 and IC2 in the indicator unit and IC3 in the electronic unit together with a 12V +ve and -ve supply derived from the 30V lines using R24, D23, C10, and R26, D21 and C11 respectively. A +20V supply derived via R25, D22 and C12 provides power to the speed pre-amplifier. One further +30V supply provides the input to a series stabiliser circuit incorporating IC3 in the electronic unit, which provides a stabilised distance reference supply.

10. The third secondary winding of T3 provides energisation for the fixed probe or rodmeter.

Calibrator

11. The calibrator is connected in circuit when required and enables signals from 0 to 60 knots, in 6-knot steps, to be injected into the speed servo control circuit. The trimmer and indicator units are disconnected from the console assembly. The two units now obtain their supply via pins 22, 23 and 1 of test lead PLC. The calibrator input is derived from the dummy load (simulating the rodmeter coil) current which is passed through resistor R1. The voltage developed across R1 is applied to the primary of transformer T1. Potentiometer RV1 is connected across a portion of T1 secondary, enabling adjustment of the transformer output. The range of adjustment is sufficient to produce the equivalent of 60 knots at sensitivities from 0.4mV/knot to 0.45mV/knot.

12. A statement of rod sensitivity dial settings (RV14) for various sensitivities and a straight line connecting these points are supplied with the test records for each equipment.

Calibrator connections

13. To connect the calibrator for use the trimmer and indicator units must be withdrawn from the console assembly. The coil/signal test lead assembly and the dummy load are connected as shown in Fig 3.12 and the Knots switch set to the required position.

REFERENCE SUPPLIES

14. Since the fixed probe input signal to the speed servo is proportional to the current through the probe coil when the unit is in use in the system it is necessary, for accuracy of speed measurement, that all reference signals used within the SDTU are also proportional to probe coil current thereby nullifying variation of supply voltage. This is achieved by using as a source of reference the voltages developed across resistors R6 and R7 which are in series with the probe coil.

Integrated Circuit Reference Supply to IC1

15. This supply is derived from the voltage developed across R6, which is sampled by the primary of transformer T2 and fed to a phase sensitive detector within IC1. It is proportional to and in phase with the fixed probe input signal.

Reset Reference Supply to RV16

16. The reset reference supply is developed between the junction of R7, R8 and the OV rail. It is applied across potentiometer RV16 to provide a linear resetting signal which is taken from the wiper.

Trimmer Unit Reference Supply

17. This supply is obtained from the voltage developed across R7 and is used to provide a reference voltage for a number of system adjustment potentiometers.

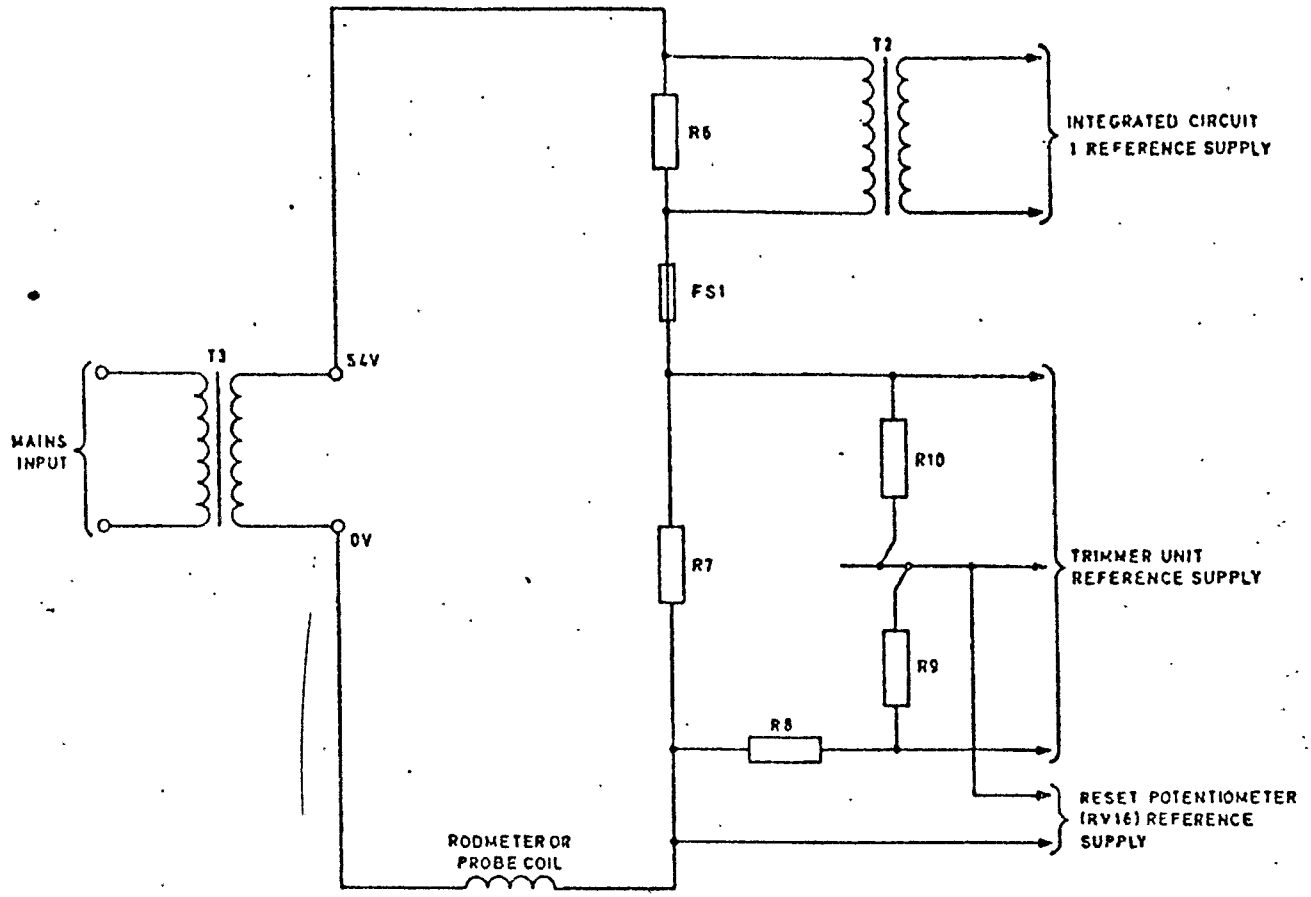


FIG. 3.3 REFERENCE SUPPLIES

ADJUSTMENT POTENTIOMETERS (TRIMMER UNIT)

18. Several adjustment potentiometers are provided in order to compensate for the following:

Non-Linearity of Signal Speed (RV1-RV9)

19. A signal in phase with the linear resetting signal (para 16) is developed across R9 and a signal of opposite phase is developed across R10. Since the linearity correction potentiometers RV1 to RV9 inclusive are connected across R9 and R10 a in or out of phase signal can be applied by adjustment of the potentiometer wiper outputs to the various tappings on the Reset Correction potentiometer RV15. RV15 has nine equally spaced tappings which correspond to 6 knot intervals.

Rod Zero (RV10) - Signal at Zero Speed

20. Electrical zero of the Reset potentiometer RV16 is approximately minus 2.6 knots, in order to provide a + or - adjustment for probes with different 'zeros', therefore a signal is required to balance that received from RV16 when the probe output is zero at zero speed. This signal is derived via potentiometer RV10 which is connected across the trimmer unit reference supply. Adjustment of the wiper

will allow the input to the servo loop input transformer T1 to be set at the level required to provide zero signal at no speed.

Instrument Zero (RV11) - Instrument Reading with Zero Signal Input

21. A signal obtained from RV11 is applied to the input of the amplifier in the speed servo to nullify any amplifier output under no signal conditions (ie balance control).

Varying Rod Sensitivities (RV12)

22. Outputs of fixed probes at the same ship's speed are generally unequal and therefore a means of adjusting the combined resetting signal to compensate is required. The outputs of the Reset potentiometer RV16, Reset Correction potentiometer RV15 and the probe zero potentiometer RV11 are therefore all taken to the per of the Rod Sensitivity potentiometer RV12, thereby allowing simultaneous justment of all three signals. In Type 21 Frigates only, the output from RV16 is further attenuated by the insertion of R12A (6.8k ohms, NS No. 5905-99-013-5117) between the junction of R12, R14, R16 and R17 and wiper of R12.

23. The Cancel Corrn and Zero switch SWB provides a means of shorting the instrument zero and resetting correction signals during setting up procedures.

SPEED SERVO SYSTEM

24. The input to the speed servo system is termed the 'speed correction signal' and is the sum of the fixed probe input and the linear reset signal, which are in phase-opposition. The speed correction signal is applied to a two stage speed preamplifier comprising VT1, VT2 and associated components. The signal is fed to the gate of VT1, a field effect transistor the drain of which is directly coupled to the base of VT2. Feedback is provided via R2. The output of VT2 is developed across R5 and d via C4 to the integrated circuit assembly IC1.

25. IC1 comprises three circuit elements, a two stage ac amplifier, a phase-sensitive detector (PSD) and a two stage dc amplifier. First stage gain is fixed externally by R29, R30 and the output is coupled via C13 to the second stage which develops the final gain. The ac amplifier output is coupled via C14 to a differential amplifier element which together with a demodulator element comprise the PSD. When the phase of the amplified speed correction signal reverses relative to that of the reference voltage (para 15) the polarity of the PSD output also reverses to provide a + or - half sinewave output which is smoothed by C15. The smoothed signal is fed to the dc amplifier comprising two elements. The first, a differential amplifier receives the PSD output together with the velocity feedback signal from the speed tachogenerator TG1 which is fed to IC1 pin 6 via RV18. The differential amplifier output is fed to the second element, a class B output stage, the power output of which is routed via IC1 pin 4 to the field winding of M1 to drive the speed servo motor.

26. A mechanical limit stop is arranged to operate on the speed servo motor shaft which prevents the local speed indicator from reading less than minus 2.5 knots or more than 60.3 knots. The mechanical limit stop also actuates limit

switches SWD or SWC at minus 2.5 or plus 60.3 knots, respectively, thereby interrupting the positive or negative supply to the appropriate output transistor of IC1. When the polarity of the PSD output changes M1 will operate in the reverse direction out of the mechanical stop. The supply to the corresponding output transistor is connected via the other limit switch. Four 15 ohm resistors, R38 and R39, and R40 and R41 are connected in series with the 30V supplies to IC1 and IC2, respectively. These resistors limit to 2A, the current flowing should the two output transistors of IC1 and IC2 be turned on simultaneously. Diodes D21 to D24, connected across these resistors prevent spurious voltage peaks reaching either pair of output transistors in IC1 or IC2 when TG2 operates. Phase advance feedback is applied to input pins 3 and 8 of IC2 via R44, R45, R46, C21 and C22.

27. The shaft of the speed servo motor M1 is mechanically coupled to a three gang potentiometer assembly RV15, RV16 and RV17. The motor drives the reset potentiometer RV16 in the direction required to reduce the speed correction signal. When the speed correction signal is zero, ie when the reset and rod signals are equal, there is no output from integrated circuit IC1 and consequently the servo motor is stationary. The local speed indicator dial is mechanically coupled to RV16 and is calibrated to indicate ship speed in knots. RV15 is the reset correction potentiometer and RV17 provides an output proportional to indicated speed which is supplied to the distance servo.

28. Two synchro transmitters, SYN 1 and SYN 2, are geared to the speed servo motor shaft to provide synchro transmission outputs.

DISTANCE SERVO SYSTEM

29. A signal is taken from the wiper of the distance potentiometer RV17 which is fed with a stabilised dc voltage from the distance reference supply. Since the shaft of the speed servo motor M1 is mechanically coupled to RV17 this signal will be proportional to indicated ship's speed. The signal from RV17 and that from tacho-generator TG2, which is proportional to the speed of the distance servo shaft, together form the distance correction signal.

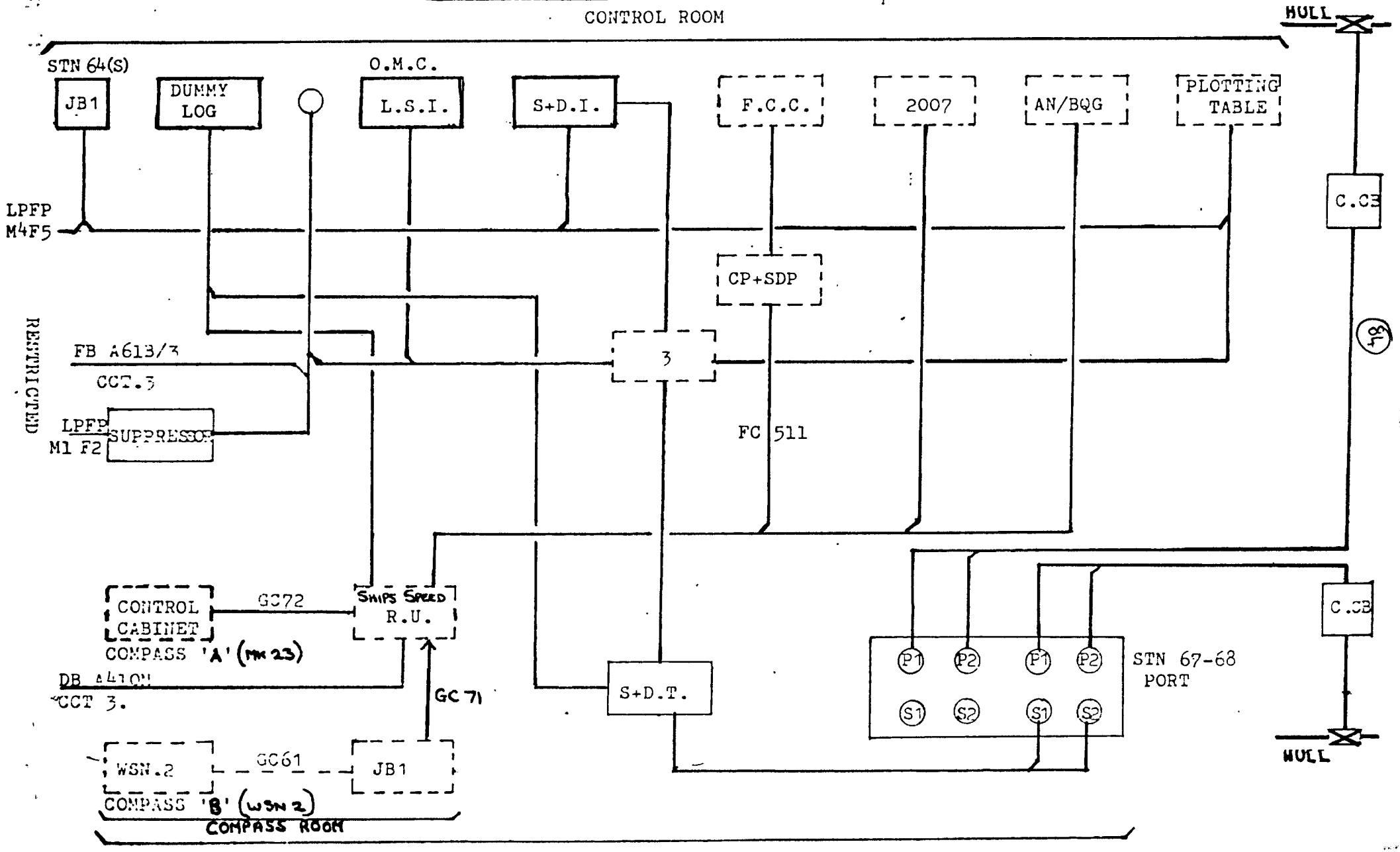
30. The distance correction signal is fed via a tacho-ripple filter, R33, R43 and C18, to pin 16 of the integrated circuit assembly IC2. This assembly comprises a high gain amplifier directly coupled to a power output stage which is routed via IC2 pin 4 to the field winding of the distance servo motor M2. Speed of the distance servo motor is therefore dependant on the magnitude of the amplifier output which varies according to the magnitude of the distance correction signal. Since this signal is proportional to indicated speed the number of revolutions of the motor shaft in a given time will be proportional to distance travelled. Coupled to the shaft via suitable gearing are a local distance display register and three pairs of cam-operated micro switches SWE and SWF, SWG and SWH and SWJ and SWK which provide 400, 200 and 100 make/break per sea mile respectively.

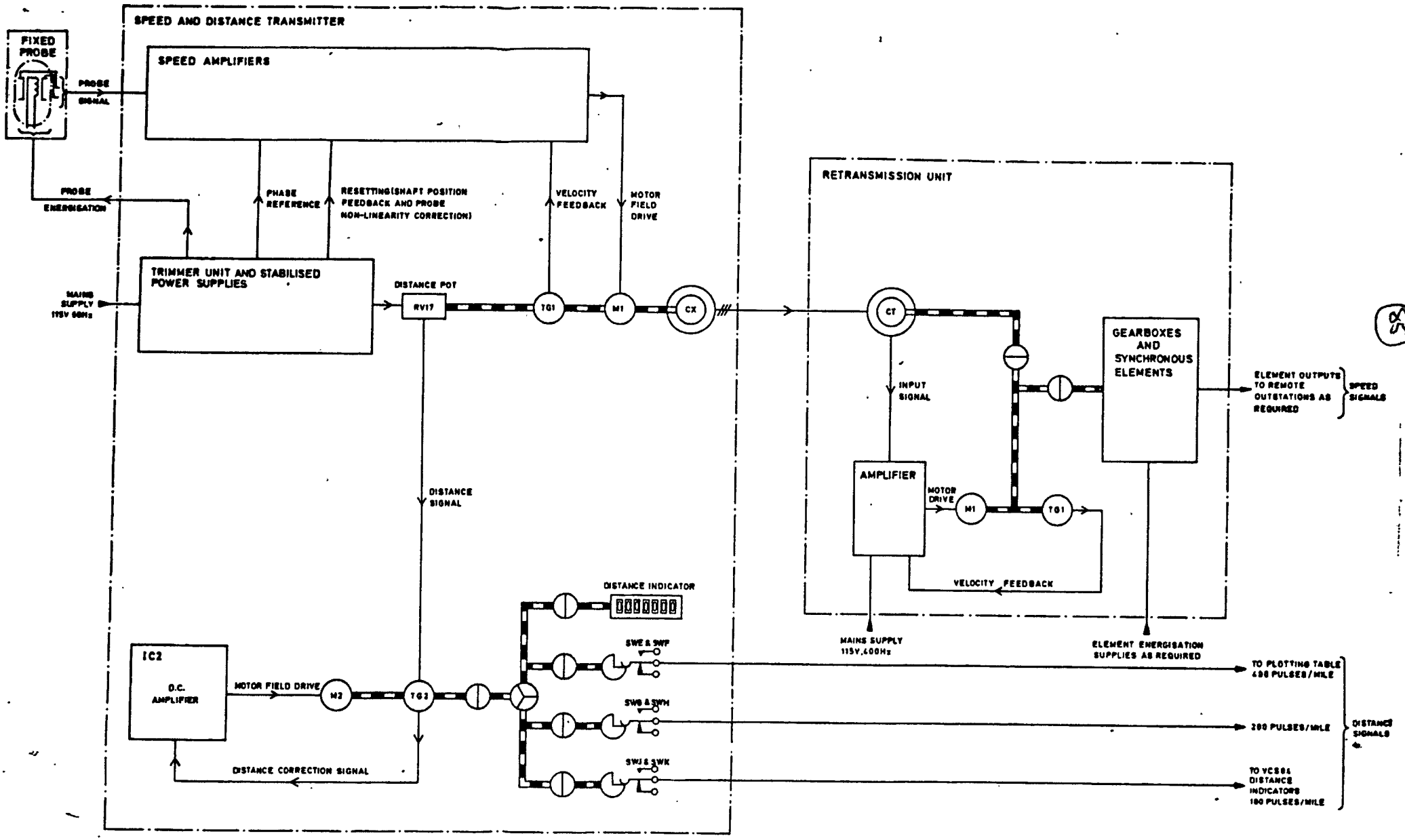
Distance Reference Supply

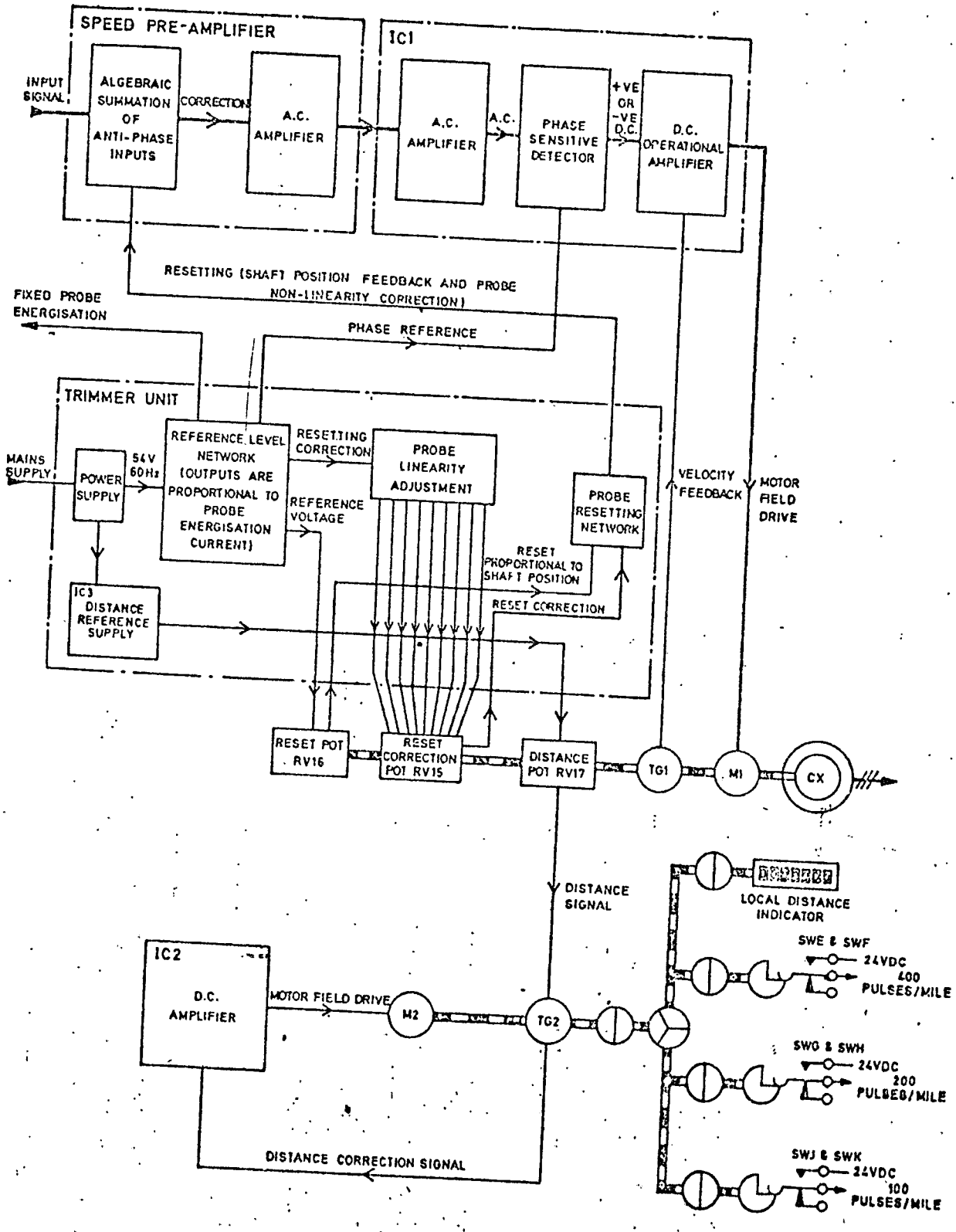
31. This is a stabilised voltage supply for the distance potentiometer RV17. Stabilisation is provided by integrated circuit IC3, a monolithic integrated voltage regulator. This assembly comprises four circuit elements, a temperature

compensated reference amplifier, an error amplifier, a power series feed transistor and a current limiter. The reference voltage output (pin 6) from the reference amplifier stage is connected via R21 to the non-inverting input (pin 5) of the error amplifier stage. This reference is matched by the output reference voltage applied to the inverting input (pin 4) of the error amplifier stage via the voltage divider chain R22, RV13, RV14 and R23. A change in the external load will cause the error amplifier to apply a signal to the series feed transistor, thereby increasing or decreasing the line impedance to restore the voltage to its original level. The voltage developed across R20 is fed back to pins 2 and 3 of the IC to provide current limiting. Potentiometer RV14 permits limited adjustment of the output voltage for distance calibration.

E.M. LOG BLOCK DIAGRAM.



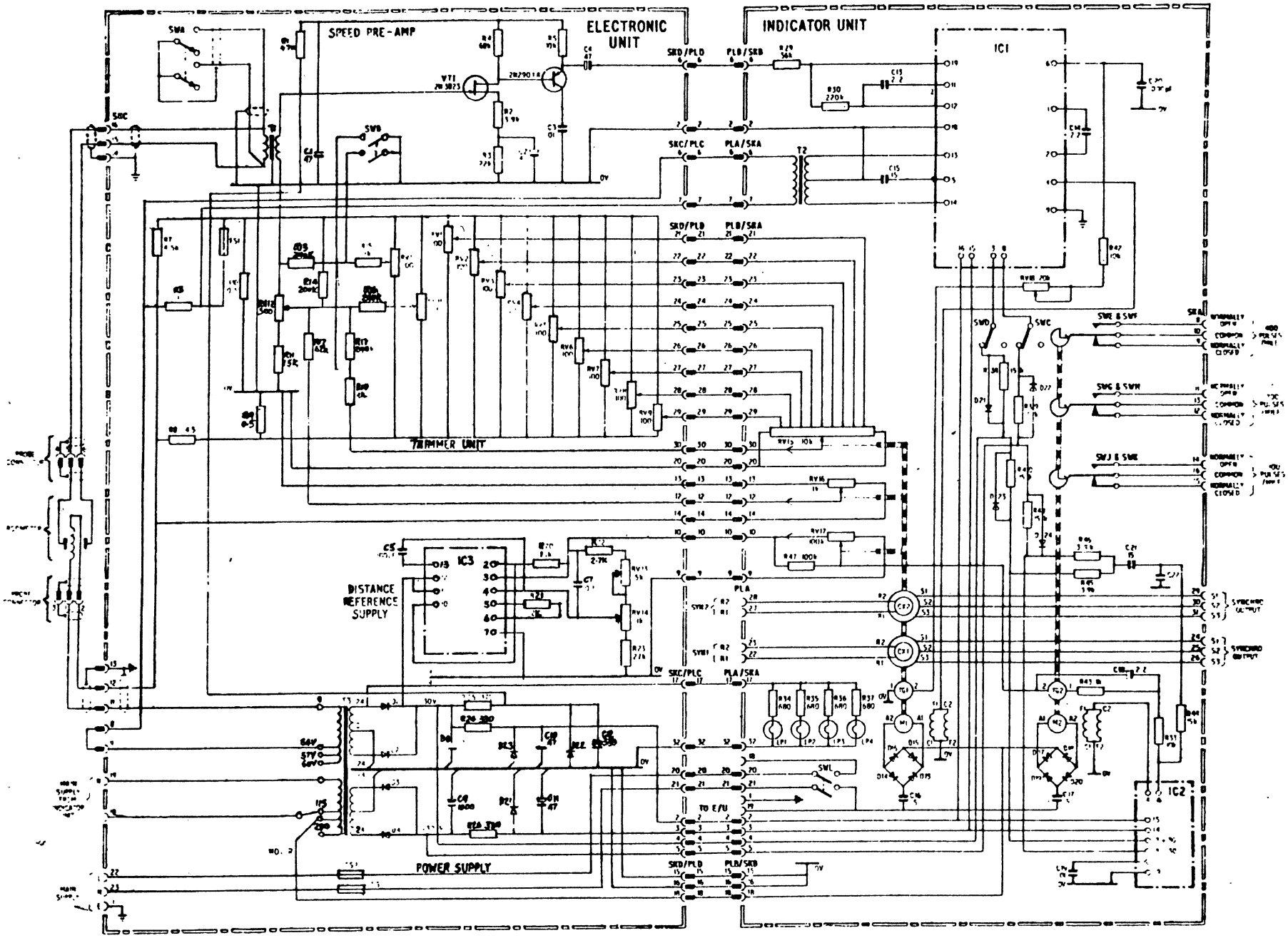

SPEED AND DISTANCE TRANSMITTER
FIXED PROBE
PROBE SIGNAL
SPEED AMPLIFIERS
PROBE ENERGISATION
PHASE REFERENCE
RESETTING(SHAFT POSITION FEEDBACK AND PROBE NON-LINEARITY CORRECTION)
VELOCITY FEEDBACK
MOTOR FIELD DRIVE
TRIMMER UNIT AND STABILISED POWER SUPPLIES
MAINS SUPPLY 115V 60Hz
DISTANCE POT
RV17
TG1
M1
CX
DISTANCE SIGNAL
RETRANSMISSION UNIT
CT
INPUT SIGNAL
AMPLIFIER
MOTOR DRIVE
M1
TG1
VELOCITY FEEDBACK
GEARBOXES AND SYNCHRONOUS ELEMENTS
ELEMENT OUTPUTS TO REMOTE OUTSTATIONS AS REQUIRED
SPEED SIGNALS
MAINS SUPPLY 115V,400Hz
ELEMENT ENERGISATION SUPPLIES AS REQUIRED
DISTANCE INDICATOR
IC2
D.C. AMPLIFIER
MOTOR FIELD DRIVE
M2
TG2
DISTANCE CORRECTION SIGNAL
SW6 & SW7
SW8 & SW9
SW5 & SW6
TO PLOTTING TABLE 400 PULSES/MILE
200 PULSES/MILE
TO VCS84 DISTANCE INDICATORS 100 PULSES/MILE
DISTANCE SIGNALS



SPEED AND DISTANCE TRANSMITTER UNIT-BLOCK DIAGRAM

E. M. LOG (TRANSISTORISED) CIRCUIT DIAGRAM

Cat No E 2338
D P 73/1511



ELECTROMAGNETIC LOG CALIBRATION

METHOD 1

The EM log Calibration is to be conducted using the Jervis Bay Sound Range plotting and timing facilities.

(A) PORT or STBD Probe. Runs at 4, 8, 12 and 16 knots are to be carried out surfaced on the Sound Range. During the runs, the results are to be recorded in the table.
(B) PORT or STBD Probe. Calibrated by comparison with the Calibrated probe. This comparison to be achieved by running the submarine dived at a steady depth, course and speed and noting the time taken to register a short distance (about 0.5 sea miles), ie, averaged speed as recorded by the Calibrated Probe. Immediately carry out the same recording with the Uncalibrated probe; speed depth and course remaining constant throughout. These records should be taken at several speeds (preferably 4, 8 and 12 knots) and from comparison, difference in setting for Rod sensitivity, indicated by overall percentage error, and linearity (errors above and/or below overall percentage error) between the Calibrated and Uncalibrated probes can be assessed and applied as necessary, when transfering from the PORT probe to the STBD probe.
It should be noted that since comparison only is being made, there is no requirement for reciprocal runs over a measured distance, but as stated above, runs on one probe and then the other must follow each other immediately and speed, course and depth must be unchanged throughout.

METHOD 2

The EM Log Calibration is to be conducted using the Mini Ranger.

(A) PORT or STBD Probe. Runs at 4, 8, 12 and 16 knots are to be carried out surfaced. During the runs, the results are to be recorded in the table.
(B) PORT or STBD Probe. Runs are to be carried out as in (A), however, it should be noted that a comparison only is being made. Differences in settings for Rod sensitivity, indicated by overall percentage error and linearity (errors above and/or below overall percentage error) between probes, can be assessed and applied as necessary when transfering from one probe to the other.

Having obtained percentage errors for all 4 speeds, calculate the mean percentage error: ie.
% ERROR 4 Kn + % ERROR 8 Kn + % ERROR 12 Kn + % ERROR 16 Kn
= MEAN PERCENTAGE ERROR.

Using BR 268(3B) EM LOG MANUAL PLATE 19, obtain sensitivity figure in uV/Knot from setting on Rod Sensitivity Pot (RV 13) ie. with POT set to position 7.00 sensitivity figure from graph reads 407 uV/Knot.

Example. If Mean Percentage Error = +14.73%.

$\frac{407 \times 14.73}{100}$ = 59.95 uV/Knot. This figure is subtracted from 407uV/Knot as a positive percentage error and requires the Log sensitivity to be reduced. 407 - 59.95 = 347.05
This corresponds to RV 13 setting of 2.20
This setting will adjust for overall rod sensitivity.
Now each linear pot requires adjustment as follows.

For example : 4 Knot % error = +19.5%.
8 Knot % error = +11.1%.
12 Knot % error = +13.6%.

4 KNOT POT No. 1: ADJUSTMENT — 4 Knot % error - mean percentage error.

19.5% - 14.73% = + 4.77%
ie. 4.77% of 4 Knots which equals $\frac{4.77 \times 4}{100}$ = +0.19

8 KNOT POT No. 2: ADJUSTMENT — 8 Knot % error - mean percentage error.

11.1% - 14.73% = - 3.63%
ie. -3.63% of 8 Knots which equals $\frac{-3.63 \times 8}{100}$ = -0.3

12 KNOT POT No. 3: ADJUSTMENT — 12 Knot % error - mean percentage error.

13.6% - 14.73 = - 1.13%
ie. -1.13% of 12 Knots which equals $\frac{-1.13 \times 12}{100}$ = -0.14

What this achieves is to adjust sensitivity to mean the errors and then make a small adjustment to each of the linear pots for the difference between each individual error and the mean.

METHOD 1

B.M. LOG CALIBRATION

RUN No.	TIME OF RUN (STOPWATCH)	DISTANCE SERVO		DISTANCE RUN	AVERAGE LOG SPEED	CALCULATED TRUE SPEED	% LOG ERROR
		START RUN	STOP RUN				
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

RUN 1.

$$V1 = \frac{3600 \times d1}{t}$$

$$L1 = \frac{3600 \times d2}{t}$$

V1 = TRUE SPEED

L1 = LOG SPEED

RUN 2.

$$V2 = \frac{3600 \times d1}{t}$$

$$L2 = \frac{3600 \times d2}{t}$$

WHERE:

d1 = MEASURED MILE.

d2 = DISTANCE TRAVELLED

t = TIME OF RUN

$$\% \text{ ERROR} = \frac{100}{1}\left(\frac{V1 + V2}{L1 + L2} - 1\right)$$

CHECK SHAFT RPM/
SM SURFACED - 22 TURNS/KNOT
SM DIVED - 25 TURNS/KNOT

METHOD 1

E.M. LOG CALIBRATION

Examples of calculations taken during E.M. Log calibration.

$$V1 = \frac{3600(\text{sec}) \times d1(\text{Measured Mile})}{t(\text{sec})}$$

$$L1 = \frac{3600(\text{sec}) \times d2(\text{Distance Travelled})}{t(\text{sec})}$$

$$\% \text{ ERROR} = \frac{100}{1}\left(\frac{V1 + V2}{L1 + L2}\right) - 1$$

EXAMPLE: 8 KNOT RUN.

RUN 1

$$V1 = \frac{3600 \times 1.388}{569} = 8.78$$

$$L1 = \frac{3600 \times 1.21}{569} = 7.65$$

RUN 2

$$V2 = \frac{3600 \times 1.388}{716} = 6.97$$

$$L2 = \frac{3600 \times 1.53}{716} = 7.69$$

% ERROR.

$$= \frac{8.78 + 6.97}{7.65 + 7.69} = (1.02 - 1) \times 100$$

= 2% ERROR

RUN No.	TIME OF RUN (STOPWATCH)	SHAFT RPM		DISTANCE RUN BY LOG (MILES)	LOG SPEED	MINI RANGER DISTANCE RUN	MINI RANGER TRUE SPEED	LOG ERROR
		PORT	STBD					

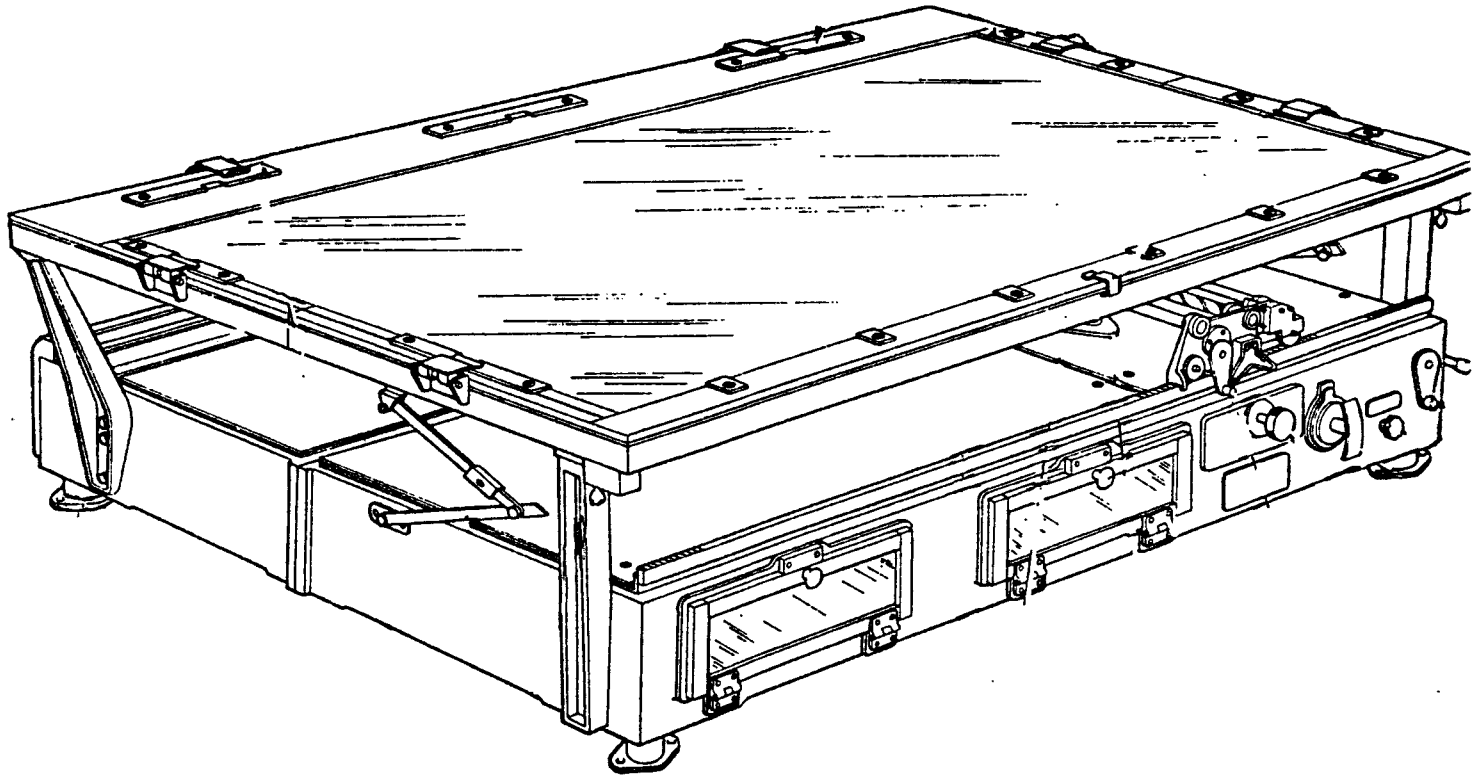
CALIBRATION RUNS ARE TO BE CARRIED OUT IN BOTH DIRECTIONS

METHOD 2

(93)

PLOTTING TABLE

ARL TYPE



PLOTTING TABLE TYPE A.R.L.

QUICK REFERENCE DATA.

POWER REQUIREMENTS.....24v DC.

INPUTS..... E.M. LOG.
GYRO.

HANDBOOK..... BR. 268(2) OPERATION AND MAINTENANCE.

ARL PLOTTING TABLE

The plotting table provides a means of plotting own ships course and distance run. Electrical impulses from the ships log and transmissions from the compass are converted into mechanical drives proportional to ships movement in North/South and East/West directions. These drives position a lamp unit which projects a spot of light onto the underside of the plotting surface. By plotting the spot of light, a record of ships course and distance travelled is obtained.

OPERATION

Impulses from the ships log energise a relay (1). The relay operates an armature (2) raising it when energised. At each movement of the armature, either up or down, the Spoked Escapement Wheel (3) is released one spoke. As the wheel is released it feeds forward on the screw thread and the Thimble (3A) closes the contact and operates the circuit for the Main Drive Motor (5), which rotates and drives a vertical shaft (10) in the Resolver. The Main Drive Motor also drives through gearing (6) the cones (7,8,9).

As the Lower cone rotates, it tends to withdraw the spoked wheel and the thimble away from the contact. In this way, the Main Drive motors revolutions are controlled by the impulses from the ships log. The resolver divides the rotations of the central vertical shaft (10) into the N/S and E/W components and the unwanted increment of each output is removed in a reversable ball clutch (14). The proportion of these two components is governed by ships head.

A Sperry repeater motor (16) displacing a Hunter (17) which operates some contacts which control the Compass Chaser Motor (18).

This motor rotates the outer ring (12) of the resolver and also recentres the Hunter. The Sperry Motor runs for course changes and so the resolver outer ring is kept lined up with ships head. The N/S and E/W rotations each pass through a gearbox (19) to allow for scale changing and are protected by a Safety Spring Clutch (20) which ruptures if an output drive reaches its mechanical limit. various drives and leadscrews finally move the cross frame to and fro for E/W movements via the nut (25), and moves the light carrage (28) backwards and forwards for N/S drives via the bevel gears(26) and the associated leadscrew (24) and (27). If for any reason the ships log cannot br used, the clock (33) may be used, it produces steady impulses for the relay and different estimated speeds may be represented by setting the scale (36), this interposes the requisite gearing between the Main Drive Motor and the Lower cone. The idler wheel must not be moved unless the cones are rotating, or flats will develope on the wheel and the cones will become scored.

ARL PLOTTING TABLES

DISTANCE DRIVE:
Impulses from the LOG cause the soleniod-operated armature to release spokes of the Escapement pinwheel, which is rotated under the influence of a coiled spring and driven along a threaded shaft. An insulated thimble carried by the pinwheel, controls spring contacts which in turn control thr MAIN DRIVE MOTOR over a range of three speeds. The motor drives the inner wheel of a resolver and provides a variable recentering drive to the pinwheel, assembly through the Logarithmic cones. It is possible to offset for Log percentage error.

COMPASS DRIVE:
The input from the compass drives an 'M' type motor to offset one side of a differential. The output of the differential displaces a cam which in turn makes contacts to control a Compass Chaser motor over a range of two speeds in either direction. The motor in running positions the outer wheel of the resolver for ships head and at the same time produces a recentering drive into the differential.

RESOLVER:
Has two gear wheels, one half the diameter of the other. The smaller is driven for distance and is rotated around the inner circumference of the larger gear which is positioned for ship's head. A point on the circumference of the inner wheel will be found to trace a straight line across the diameter of the outer, and the direction of this line will be determined by the ship's head set on the outer. In practice a stud isfitted at this point which runs in two sliders set in quadrature. The sliders drive racks and pinions to transmit away the sine and cosine increments of the course and distance made good. (ie: N/S and E/W components).

180° REVERSABLE CLUTCHES:
Are fitted in the N/S and E/W output drives to remove unwanted increments of the rack movements to ensure a uni-directional drive, and to ensure that the output is in the correct direction by reversing there function at the requisite cardinal points.

OUTPUT DRIVES:
The N/S and E/W rotations each pass through a gear box for scale changing and are protected by a Safety Spring Clutch which ruptures if an output drive reaches it's mechanical limit. A cross frame carring a point light source denotes ship's position. This frame is driven bodily by the E/W drive and the light is moved along the frame by the N/S drive.

POWER SUPPLY:
24 Volts D.C.

LINING UP THE RESOLVER:
(1) Break the GYRO switch.
(2) Engage locking bar with the differential cam.
(3) Rotate handwheel to line resolver to ship's head
(4) Disengage locking bar.
(5) Make the GYRO switch.

CLOCK DRIVE:
When the ship's log is out of action it is possible to simulate the ship's speed through the water using a make and break driven by a clock to pulse the pin wheel's operating soleniod. (wind the clock and put LOG/OFF/CLOCK switch to CLOCK). As the clock gives ½ second impulses which are equivalent to 18 knots it is necessary to offset the scale setting to simulate actual speed. This is achieved by setting a scale figure of actual ship's speed against the required scale instead of the normal arrow.